

SECTION P, PART 0

MONITORING

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P0 MONITORING

The P section of the SFD covers the monitoring function of the Automatic Monitor Register Sender Test (AMRST).

In monitoring, the AMRST is associated with Originating Registers (OR), Outgoing Senders (OS), and Incoming Registers (IR) and independently records the number pulsed into registers or out of an outgoing sender. This number is compared with the number the originating and incoming registers send to the marker or the outgoing sender receives from the marker. If these numbers do not agree, a trouble record card is perforated identifying the circuit which was monitored and giving other information relative to the trouble. If the numbers agree, the AMRST releases. In either case, the service call is not affected.

There are three basic modes of monitoring:

- (1) For progressive monitoring the AMRST is arranged to monitor successively on OR, OS, and IR.
- (2) For a particular type the AMRST is arranged to monitor OR only, OS only, or IR only.
- (3) For a particular circuit, the monitor is arranged to monitor on a particular OR, OS, or IR.

The P0 part describes the set up of the AMRST for monitoring registers and senders.

P0-1 MONITORING SET UP

The type of monitoring tables shown on SFD-P002 and P003 summarize, in tabular form, the keys and switches used to establish a particular type of monitoring. A single line is used to separate a particular function with its associated figure, option, key, or switch. The double line within the single lines is used to separate the various options on vintages of AMRST or MTC frames.

P0-1.1 PROGRESSIVE MONITORING

On the progressive monitoring table, SFD-P002, the MAC key on the AMRST frame is operated. After one minute of warm up time, to allow for the vacuum tubes to heat, the STM key on the AMRST frame is operated to

start progressive monitoring. The AMRST is arranged to monitor successively on OR, OS, and IR. A 10-step allotter circuit is provided which steps once per monitored call. A cross-connection from each step except the first and the last determines what type of circuit will be monitored in that position. The cross-connections are to terminals OR for originating registers, OS for outgoing senders, and IR for incoming registers. This permits the monitoring to be apportioned in relation to the number of each type of circuit in the office. The monitoring must start with OR and progress successively to OS and IR and there must be at least one step for each type of circuit. An automatic advance of the allotter circuit is provided if no call is monitored for one minute. Details of monitoring OR, OS, and IR progressively is the same as described below for MOR, MOS, and MIR.

PO-1.2 MONITORING ORIGINATING REGISTERS (MOR)

After the keys on the AMRST are set per table on SFD-P002 for MOR the call proceeds in the following manner.

At the time a Dial Tone Marker (DTM) establishes a dial tone connection, it requests the use of the AMRST on that call. The DTM which is successful in selecting the AMRST through the preference chain will connect the selected OR to the AMRST. The AMRST then remains attached to that OR during the period of register usage.

During dialing, the digits are recorded in the OR and also independently recorded in the AMRST. When all digits have been received, the OR selects a Completing Marker (CM) and signals this fact to the AMRST. In response to this signal, the AMRST bids for the MTFC to gain access to that CM. A signal is also passed from the AMRST through the OR to the CM to inform the CM that it is handling a monitored call.

The number passed from the OR to CM is registered on relays in the AMRST and after a sufficient registration interval, the AMRST releases the connection through the MTFC. The AMRST then compares the number it recorded from the OR input with the number passed from OR to CM. If they are the same the AMRST restores to normal and becomes available to be associated with the OR used on the next call. If the numbers do not match, the AMRST again bids for the MTFC, this time to gain access to the trouble recorder. A trouble record is taken and the AMRST then becomes available to be associated with an OR on the next call.

PO-1.3 MONITORING OUTGOING SENDERS (MOS)

After the keys on the AMRST are set per table on SFD-P002 for MOS, the call proceeds in the following manner.

When the AMRST is prepared to monitor outgoing senders, the marker (MP-relay) preference chain is made operative. The path to the preference relay is closed only when the CM starts to select an OS. When the CM selects the AMRST through the preference chain, the CM is informed that the call is to be monitored. The AMRST then is given access to the CM through the MTFC.

The number passed from the OR to CM is then registered in the AMRST, since this also is the number which the CM passes to the OS. At the same time, other information passed to the OS such as number of digits to delete, if any, are recorded in the AMRST. When the CM first connects to the OS it connects the OS to the AMRST, the AMRST remains connected until the OS restores to normal.

During the time the AMRST is connected to the CM, the AMRST records the location of the outgoing trunk used on the call. When the CM has progressed to the point of connecting the trunk to the calling line the AMRST releases the connection through the MTFC to the CM, the CM releasing normally. The AMRST then records the outpulsed number and upon completion of pulsing compares the outpulsed number with that received from the CM. If the outpulsed numbers agree with the numbers received from the marker the AMRST releases and becomes available for another OS circuit. If the numbers do not agree the trouble recorder is requested and a trouble record taken, then the AMRST releases and becomes available for another OS circuit.

PO-1.4 MONITORING INCOMING REGISTERS (MIR)

After the keys on the AMRST are set per table on SFD-P002 for MIR, the call proceeds in the following manner.

When the AMRST is prepared to monitor incoming registers, a preference chain consisting of one relay per IR is made operative. When an incoming trunk selects an IR, the IR will request the use of AMRST on that call. If the IR successfully selects the AMRST through the preference chain, the IR will be connected to the AMRST for the duration of that IR usage.

During dialing, the digits are recorded in the IR and also independently recorded in the AMRST. When all digits have been received, the IR selects a (CM) and signals this fact to the AMRST. In response to this signal, the AMRST bids for the MTFC to gain access to that CM. A signal is also passed from the AMRST through the IR to the CM to inform the CM that it is handling a monitored call.

The number passed from the IR to the CM is registered on relays in the AMRST and after a sufficient registration interval, the AMRST releases the connection through the MTFC. The AMRST then compares the number it recorded from the IR input with the number passed from the IR to the CM. If the numbers match the AMRST restores to normal and thus becomes available to associate itself with the IR used on the next call. If the numbers do not match, the AMRST again bids for the MTFC, this time to gain access to the trouble recorder. A trouble record is taken and the AMRST then becomes available to be associated with an IR on the next call.

PO-1.5 MONITORING A PARTICULAR ORIGINATING REGISTER (MPOR)

After the key(s) and switch(es) on the Master Test Control (MTC) circuit and AMRST are set per table on SFD-P003 for MPOR, the call proceeds in the following manner.

The Dial Tone (DT) class of test is used as a means of connecting the AMRST to a particular OR for repeated monitoring on that OR.

The AMRST is set for OR repeat monitoring and the MTC is set up for a DT class of test with keys and switches operated to direct the DTM to connect to the particular OR which is to be monitored on a repeat basis. The AMRST grounds the M lead which is extended through the DT relay to the OR via the DTM to operate the M relay in the OR. When the AMRST recognizes the operation of M relay in the OR, it provides locking ground and removes the ground from the M lead to the MTC. Once this connection has been set up, the MTC may be released for other uses while the AMRST remains connected to the OR through its M relay. Each time that particular OR is seized in service the call will be monitored.

PO-1.6 MONITORING A PARTICULAR OUTGOING SENDER (MPOS)

After the key(s) and switch(es) on the AMRST are set per table on SFD-P002 for MPOS, the call proceeds in the following manner.

The marker preference chain is not used. The particular outgoing sender desired is selected by setting the keys or switches of the AMRST. Only when a CM picks this particular OS will the AMRST be called in. The call from this point is the same as MOS call. Each succeeding time the marker selects this particular OS the call will be monitored.

PO-1.7 MONITORING A PARTICULAR INCOMING REGISTER (MPIR)

After the key(s) and switch(es) on the AMRST are set per table on SFD-P002 for MPIR, the call proceeds in the following manner.

The call will progress the same as for monitoring incoming registers except that the operating paths of the preference relays of all other incoming registers are opened. Only the preference relay of the IR selected by the key or switch settings on the AMRST will operate. Each succeeding time that the particular IR is selected the call will be monitored.

PO-2 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts, except as noted on SFD-A103. However, the sequence charts in the P section depict the switch type MTC circuit with connector SD-27718-01.

SECTION P, PART 1
ESTABLISHING THE CONNECTION

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P MONITORING

The Automatic Monitor Register and Sender Test Circuit (AMRST) is used to monitor the pulsing performance of the Originating Registers (OR), Incoming Registers (IR), and Outgoing Senders (OS) of a No. 5 Crossbar Central Office while they are being used in service, and also to test these same circuits. This section of the SFD covers the monitoring functions only.

The AMRST is arranged to monitor progressively on originating registers, outgoing senders, and incoming registers. In addition to progressive monitoring, monitoring can be confined to originating registers only, to outgoing senders only, or to incoming registers only. A further choice permits exclusive monitoring on a particular OR, IR or OS. The general sequence of operation for monitoring is as follows:

(a) Originating Register (OR) Monitoring

The MAC key of the AMRST should be operated and the tubes of the amplifier permitted to heat for at least one minute. The selection of the type of monitoring is made by operating the keys as described in subsequent paragraphs. The STM key of the AMRST is operated and the AMRST is now ready to be connected to an OR. When the DTM has progressed to the point of connecting the calling line to the OR, the M relay of the OR operates connecting the OR to the AMRST.

After the AMRST is connected to the OR via the M relay, it prepares to accept pulses. The pulses are received at a high impedance so as not to interfere with the pulse receiving of the OR. The pulses are then received by the AMRST where they are recorded and stored.

After all the digits have been received by the OR and AMRST, the register seizes a Completing Marker (CM) through the ORMC. The CM realizing it is handling a monitor call (MON relay operated) seizes the Master Test Frame Connector (MTFC) which connects it to the AMRST. The digits stored in the OR, along with other information, are passed through the ORMC, CM, and MTFC to the AMRST where they are compared against the digits pulsed into the AMRST. If the digits match, the AMRST restores to normal and is ready to accept the next call. If they do not match a trouble record is taken and the AMRST is ready to accept the next call.

(b) Outgoing Sender (OS) Monitoring

The MAC key of the AMRST should be operated and the tubes of the amplifier permitted to heat for at least one minute. The selection of the type of monitoring is made by operating the keys as described in subsequent paragraphs. The STM key of the AMRST is operated and the AMRST is now ready to be connected to an OS. The CM is informed that it is handling a monitored call (MON relay operated) and seizes the MTFC.

After the CM seizes the OS, the M relay of the OS operates connecting the OS to the AMRST.

The called number and other miscellaneous information is passed and recorded in the AMRST via the MTFC. This same information is passed to and stored in the OS.

After the OS receives the start pulse signal, the digits stored in the OS are outputted into the AMRST where they are received at a high impedance so as not to interfere with the pulsing performance of the OS. The pulses are received by the AMRST where they are counted and stored.

After the OS completes outputting, the digits outputted by the OS into the AMRST are compared against the digits received from the CM via the MTFC. If the digits match, the AMRST restores to normal and is ready to accept the next call. If they do not match a trouble record is taken first then the AMRST restores to normal where it is ready to accept the next call.

(c) Incoming Register (IR) Monitoring

The MAC key of the AMRST should be operated and the tubes of the amplifier permitted to heat for at least one minute. The selection of the type of monitoring is made by operating the keys as described in subsequent paragraphs. The STM key of the AMRST is operated and the AMRST is now ready to be connected to an IR. When the IR is seized by the Incoming Register Link (IRL), the M relay of the IR operates connecting the IR to the AMRST.

After the AMRST is connected to the IR via the M relay it prepares itself to accept the pulses. The pulses are received at a high impedance so as not to interfere with the pulse receiving of the IR. The pulses are then received by the monitor where they are counted and stored.

After all the digits have been received by the IR and AMRST, the IR seizes a CM through the Incoming Register Marker Connector (IRMC). The CM realizing it is handling a monitored call (MON relay operated) seizes the MTFC which connects to the AMRST. The digits stored in the IR, along with other information, are passed through the IRMC, CM, and MTFC to the AMRST where they are compared against the digits pulsed into the AMRST. If the digits match, the AMRST restores to normal and is ready to accept the next call. If they do not match a trouble record is taken first and then the AMRST is ready to accept the next call.

P1 ESTABLISHING THE CONNECTION

(a) Originating Register (OR) Monitoring

The MAC key of the AMRST should be operated and the tubes of the amplifier permitted to heat for at least one minute. The selection of the type of monitoring is made by operating the keys as described in subsequent paragraphs. The STM key of the AMRST is operated and the AMRST is now ready to be connected to an OR. When the DTM has progressed to the point of connecting the calling line to the OR, the M relay of the OR operates connecting the OR to the AMRST.

(b) Outgoing Sender (OS) Monitoring

The MAC key of the AMRST should be operated and the tubes of the amplifier permitted to heat for at least one minute. The selection of the type of monitoring is made by operating the keys as described in subsequent paragraphs. The STM key of the AMRST is operated and the AMRST is now ready to be connected to an OS. The CM is informed that it is handling a monitored call and seizes the MTFC.

After the CM seizes the OS, the M relay of the OS operates connecting the OS to the AMRST. The called number and other miscellaneous information is passed and recorded in the AMRST via the MTFC. This same information is passed and stored in the outgoing sender.

(c) Incoming Register (IR) Monitoring

The MAC key of the AMRST should be operated and the tubes of the amplifier permitted to heat for at least one minute. The selection of the type of monitoring is made by operating the

keys as described in subsequent paragraphs. The STM key of the AMRST is operated and the AMRST is now ready to be connected to an IR. When the IR is seized by the IRL, the M relay of the IR operates connecting the IR to the AMRST.

P1-1 PROGRESSIVE MONITORING

The following paragraphs describe how the AMRST begins selecting originating registers and progresses successively to outgoing senders and incoming registers under control of the allotter circuit.

P1-1.1 PREPARATION TO CONNECT TO FIRST ORIGINATING REGISTER

To monitor progressively all the AMRST selection keys should be normal and the STM key operated. The operation of the STM key (SFD-P108) operates the STM relay and in turn the STM1 relay. These relays serve as off-normal relays for the monitoring operation of the AMRST, closing off-normal grounds where necessary and closing through leads from the originating registers, incoming registers, outgoing senders and markers to the AMRST. Relay STM1 operates MBN (SFD-P114) which operates the MB-relays (SFD-P111).

Ground is then closed through all operated MB-relays to operate APA relay (SFD-P109) which locks and operates the OR relay. The OR relay operates the STM2 relay (SFD-P109) and closes ground to the ORS lead to all dial tone markers (SFD-P111). If any DTM is serving a dial tone call, it will return this ground on the ST lead via marker cross connects. The STM2 relay opens the operating path of the APA relay and releases the MBN relay which in turn opens the operating path of all MB-relays. If any DTM is busy on a dial tone connection at this time, the MB-relay associated with that marker will be held operated by ground on the ST lead. The OR relay also closes ground to the last MP-relay which is the work lead of the MP-relay chain for OR monitoring. The AMRST is now ready to connect to an OR. Any DTM starting a dial tone call will ground the ST lead to operate an MP-relay to seize the AMRST.

P1-1.1.1 Allotter Circuit (SFD-P109)

The purpose of the AP(A-K) relay chain is to apportion the monitoring sequence of the originating registers, outgoing senders, and incoming registers. Progressive monitoring always starts with the APA relay and originating registers. The remaining relays have punchings AP(B-J) which can be cross-connected to the OR, OS, or IR punchings to determine what circuit shall be monitored in that position. However, the progression must be from originating registers to outgoing senders and then

to incoming registers. Also at least one step must be provided for each type of circuit. If there are no outgoing senders, for example, then the automatic advance feature of the allotter will advance the monitor from the step provided for outgoing senders at the end of a timed interval.

The following table gives some examples of how the AP(B-J) punchings can be cross-connected for the percentage of time the AMRST is to monitor originating registers, outgoing senders, or incoming registers. When originating registers and incoming registers are to be monitored for only 10% of the time no cross-connection is required because originating registers are always assigned APA and incoming registers are always assigned APK position of the allotter circuit.

<u>Amount (%) of Automatic Monitoring Time Required on</u>			<u>On AP T.S. J23253E Conn Terminals</u>		
<u>Originating Registers</u>	<u>Outgoing Senders</u>	<u>Incoming Registers</u>	<u>(OR) To</u>	<u>(OS) To</u>	<u>(IR) To</u>
10	10	80	-	B	C,D,E,F, G,H,J
10	80	10	-	B,C,D,E, F,G,H,J	-
80	10	10	B,C,D,E, F,G,H	J	-

For more cross-connection variations see SD-25680, D13.

When the AMRST is seized, ground is extended through the operated APA relay, which previously operated and locked to the STM1 relay under control of APB relay, to operate the APB relay. The operation of the APB relay opens the operating path of the APB relay and closes the locking path through the operated STM1 relay. This action prevents the locking ground from backing up on the advance lead. Also the operated APB relay transfers the locking path of the APA relay to the advance lead which is through the operated contacts of the ONM1 relay. When ground is removed from the advance lead at the end of the call release of the ONM1 relay, the APA relay releases. The allotter circuit steps once per call as just described through to the APK relay. When the APK relay operates, it closes a circuit to operate the APA relay and also puts a shunt on contacts 5 and 6 top of the APA relay so that when the APA relay operates it will not break its own operating path. The operating path of the APB relay is run through normal contacts of the APK relay so that, when the APA relay operates through the APK relay, APB relay will not operate immediately but will wait until the APK relay has released and the next call started.

P1-1.1.2 Allotter Timing (SFD-P115)

If the AMRST is not used for a period of one minute, the timing circuit consisting of the TAP1 and TAP2 (timing advance allotter) relays and associated tube and resistors functions to advance the allotter one step. This is to prevent the AMRST from remaining in the IR or OS monitoring positions during periods when interoffice traffic is light.

The TAP2 relay is operated whenever the allotter chain is functioning. The operation of relay TAP2 removes a shunt from the TAP timing capacitor and connects ground through the TAP1 relay to the TAP capacitor which starts to charge in series with the TAP3 timing resistor. If no call is received in one minute the TAP tube will fire and operate the TAP1 relay and operate the next AP- relay (SFD-P109). The operation of the TAP1 relay also starts the release of the TAP2 relay and operates the MSR relay (SFD-P108). The MSR and MSR1 relays are operated at this time to simulate a call in case the monitor is progressing to another type of monitoring. When the TAP2 relay releases, TAP1 relay releases releasing the AP- relay, MSR, MSR1 and any relays operated from the MSR1 relay. Relay TAP1 also permits the TAP2 relay to reoperate to start the next timing cycle.

P1-1.2 PROGRESSION FROM ORIGINATING REGISTER TO OUTGOING SENDER (SFD-P109)

At the start of monitoring of the final originating register call, an AP- relay operates and operates the OS relay. The OS relay connects ground to the OSS lead to the CM (SFD-P111). If any CM is handling an outgoing sender class call, this ground will be returned on the ST lead via cross-connects in the CM. Although this may operate an MP- relay, it will cause no reaction since the MP- relay chain has already been seized by the entering OR call.

At the end of the OR call the AP-, OR, and MSR relays release. The OR relay releasing prepares for OS monitoring by opening the work lead of the MP- relays for OS monitoring under control of the MSR1 relay (SFD-P111). The OR relay also opens the ORS lead to the dial tone markers to terminate request from the dial tone markers for OR monitoring.

The MSR relay is slow-release to insure that all relays of the AMRST release at the end of a call before the AMRST accepts another call. When MSR1 releases, it releases the MBN relay (SFD-P114) which opens the operating paths of all MB- relays (SFD-P111), releasing all except those associated with markers handling outsender calls. The MSR1 relay also closes ground to the work lead of the MP- relays (SFD-P111)

for OS monitoring, and the AMRST is now ready to connect to an OS. The MBN and MB- relays make a similar busy test of all markers at the completion of each originating register or outgoing sender monitored call. The operating path of MBN is controlled by the OR and OS relays so that the MBN and MB- relays will not operate unnecessarily during IR monitoring or during monitoring of a particular OS or OR.

P1-1.3 PROGRESSION FROM OUTGOING SENDER TO INCOMING REGISTER
(SFD-P109, P113, P114)

At the start of monitoring of the final OS call, an AP- relay operates and in turn operates the IR relay. The IR relay operates the IRB (incoming register bias) relay to prepare the amplifier circuit for IR monitoring. When MSR1 relay reoperates (SFD-P108), it operates the RBN-relays (SFD-P114) through the operated IR relay, and in turn operates the IRB- relays (SFD-P113) in preparation for a busy test of incoming registers.

At the completion of monitoring of the OS call, relay OS releases, opening the OSS lead to the markers to prevent further requests from the markers for outgoing sender monitoring service. The MBN relay and all MB- relays are released since they are not required for IR monitoring. The OS relay also closes battery through operated contacts of the IR relay to the IRP- relay chain.

When MSR1 releases, all RBN- relays release, opening the operating paths of all IRB- relays. However, any IR on which a call is in progress, as indicated by a grounded ON lead from the IRL through SPR- normal, will hold its associated IRB- relay operated to prevent starting monitoring late on this call. A similar test is made prior to the start of each IR monitored call.

The AMRST is now ready to connect to an IR. When an IR is selected by the IRL, the ON- lead from the IRL is grounded to operate the associated IRP- relay and thus start monitoring of that call.

P1-1.4 PROGRESSION FROM INCOMING REGISTER TO ORIGINATING REGISTER
(SFD-P109)

At the start of monitoring of the final incoming register call, the APA relay operates and operates relay OR. When relay MSR1 operates, it operates MBN and all MB- relays.

At the conclusion of the incoming register call, relay IR releases, releasing IRB and all RBN- and IRB- relays. The IR relay also closes ground to the ORS lead to the dial tone markers monitoring preference chain (SFD-P109).

When relay MSR1 releases, relay MBN releases and, through the MB- relays, tests the markers for calls in progress. Ground is closed to the work lead of MP- relays for OR monitoring, and the AMRST is now ready to connect to an OR.

P1-2 TYPE OF CIRCUIT MONITORING

The following paragraphs describe how the AMRST confines monitoring to originating registers only, to outgoing senders only, or to incoming registers only.

P1-2.1 MONITORING ORIGINATING REGISTERS ONLY

To monitor originating registers only, the MOR key of the AMRST should be operated, followed by the STM key.

The operation of the STM key operates the STM relay and in turn the STM1 relay. These relays serve as off-normal relays for the monitoring operation of the AMRST, closing off-normal grounds where necessary and closing through leads from the originating registers, outgoing senders, incoming registers and markers to the AMRST. The STM1 relay operates MBN relay (SFD-P114) which operates the MB- relays (SFD-P111).

Ground is then closed through STM2 relay normal and all MB- relays operated to operate relay OR(SFD-P109). With MOR key operated the allotter circuit will not function on the test. Relay OR locks to the STM1 relay through a make contact of the MOR key and operates relay STM2 and closes ground to the ORS lead to all dial tone markers. If any DTM is serving a dial tone call, it will return this ground on the ST lead. The STM2 relay opens the operating path of relay MBN. The MBN relay opens the operating paths of all MB- relays. If any DTM is busy on a dial tone connection at this time, the MB- relay associated with that DTM will be held operated by ground on the ST lead. The OR relay also closes ground to 5T of the last MP- relay which is the work lead of the MP- relay chain for OR monitoring (SFD-P114).

The AMRST is now ready to connect to an OR. Any DTM starting a dial tone call will ground the ST lead to operate an MP- relay to seize the AMRST. Since the allotter circuit does not function, originating registers are monitored continuously.

P1-2.2 MONITORING OUTGOING SENDERS ONLY

To monitor outgoing senders only, the MOS key of the AMRST should be operated, followed by the STM key.

The operation of the STM key operates the STM relay and in turn the STM1 relay. These relays serve as off-normal relays for the monitoring operation of the AMRST, closing off-normal ground where necessary and closing through leads from the originating registers, incoming registers, outgoing senders and markers to the AMRST. The STM1 relay operates MBN relay which operates the MB- relays. Ground is then closed from relay STM2 normal through all MB- relays operated to operate OS relay which locks to relay STM1 through the MOS key. With the MOS key operated, the allotter circuit will not function on this test (SFD-P109). The OS relay operates the STM2 relay which releases MBN relay which opens the operating paths of all MB- relays. If any CM is busy on an outgoing sender call at this time, ground from the OS relay to the CM on the OSS lead will be returned on the ST lead to hold the associated MB- relay operated. The OS relay also connects ground to 2T of the last MP- relay which is the work lead of the MP- relay chain for OS monitoring (SFD-P212).

The AMRST is now ready to connect to an OS. Any CM starting an OS call will ground the ST lead to operate the MP- relay to seize the AMRST (SFD-P111). Since the allotter circuit does not function, outgoing senders are monitored continuously.

P1-2.3 MONITORING INCOMING REGISTER ONLY

To monitor incoming registers only, the MIR key of the AMRST should be operated, followed by the STM key.

The operation of the STM key operates the STM relay and in turn the STM1 relay. These relays serve as off-normal relays for the monitoring operation of the AMRST, closing off-normal grounds where necessary and closing through leads from the originating registers, outgoing senders, incoming registers and markers to the AMRST. The STM1 relay operates the RBN- relays which in turn operate all IRB- relays. When all IRB- relays operate, a path is closed from break contacts of STM2 relay to operate relay IR. The IR relay locks to STM1 relay through the MIR key, closes battery to the IRP- relay chain, and operates relay STM2. The STM2 relay releases all RBN- relays and in turn all IRB- relays which are not associated with busy incoming registers.

The monitor is now ready to connect to an IR. When an IR is seized by the IRL, ground will be connected to the IRP- lead to select the AMRST. Since the allotter does not function, incoming registers are monitored continuously.

P1-3 CONNECTION OF AMRST TO REGISTERS AND SENDERS

The following paragraphs describe how the AMRST connects to an OR, OS, or IR once the type of monitoring has been selected by the keys of the AMRST (see SCD P1-1 or P1-2).

P1-3.1 CONNECTION OF AMRST TO ORIGINATING REGISTER

After the progressive or circuit type (example: outgoing senders only) monitoring has been selected and the MAC and STM keys have been operated as described in SCD P1-1 or P1-2, the AMRST is ready to connect to an OR. A DTM starting to setup a dial tone connection will connect ground to the ST lead operating the associated MP- relay (SFD-P111). The MP- relays form a chain circuit which permits only one DTM at a time to gain access to the AMRST. If the intermediate MP- relay is operated (SFD-P111), the last MP- relay cannot operate because its operating battery is open. The first MP- relay can operate but will perform no function since its work contacts are open at the MP- relay of the intermediate circuit.

The MP- relay which gains preference in the chain returns ground on the M lead to its DTM (SFD-P114). When the DTM progressed to the point of connecting the calling line to the originating registers, this ground is extended through the trunk link frame and connector circuit to operate the M relay of the OR. The M relay connects the ON, MB, H, MST, MON, LK, MST1, and T and R leads from the OR to the AMRST. These leads are used by the AMRST to check the operation of the originating register.

As a result of seizure of the OR by the DTM, ground is connected to the ON lead from the OR to the AMRST operating the DOR relay (SFD-P112) which serves as a cut-in relay for leads from the OR to the AMRST controller. The DOR relay DOR operates the CMS relay (SFD-P114) which opens the work lead on the MP- relays for OR monitoring. This prevents a second DTM from operating the M relay of a second OR if the MP- relay chain advances due either to release of the first DTM or a difference in operating times of the MB- relays. The DOR relay connects a ground to the LK lead to the OR to lock the M relay. The DOR relay operates the DON relay to prepare the dial pulse counting circuit for receiving pulses.

Ground on the MST lead from the OR operates the RPS1 relay (SFD-P108) which serves as a register off-normal relay since it operates for both incoming and originating register calls. The RPS1 relay opens the operating path of relay SON to prevent this relay from operating if the call is extended to an outgoing sender.

The RPS1 relay closes the operating path for relay RPE1 but this relay remains normal at this time due to a shunting ground on the MST lead.

The DOR relay also operates the ORN relay (SFD-P108) which prepares the circuit for OR monitoring. The ORN relay operates the AS, ASA, MK relays (SFD-P211) to prepare the steering circuit for receiving the A digit. The ORN relay also operates the ONM1 and ONM2 relays which serve as cut-in relays and also furnish general monitoring off-normal grounds. The ONM1 relay operates the TMA and TMB relays (SFD-P115) to start AMRST timing. A ground is closed to the allotter advance lead to prepare for advance of the monitoring allotter circuit, (progressive monitoring mode only). The ONM2 relay operates the ONR relay (SFD-P109) to furnish off-normal grounds. The MSR and MSR1 relays are operated at this time to simulate a call in case the AMRST is progressing to another type of call.

When the SR relay of the OR operates, the MAC1 relay operates on the H lead from the OR and closes a path to operate the ORM relay (SFD-P109). Operation of relay ORM is delayed until this time so that the register pulsing circuit will be established before relay ORM connects the dial pulse amplifier to it. The MAC1 relay operates relay MAC2 (SFD-P108) which locks to relay ONM1. Any release of relay MAC1 following operation of relay MAC2 is used to indicate that a call has been abandoned in the OR. The MAC2 relay closes a locking circuit for DOR relay through normal contacts of relay RN. Closure of the locking circuit of relay DOR is delayed until this time so that the AMRST will not lock up until it is prepared to recognize an abandoned call.

P1-3.2 CONNECTION OF AMRST TO OUTGOING SENDER

After the progressive or circuit type (example: originating registers only) monitoring has been selected and the MAC and STM keys have been operated, as described in SCD P1-1 or P1-2, the AMRST is ready to connect to an OS. A CM finding that a call requires an OS will connect ground to the ST lead operating an MP- relay (SFD-P111). Operation of the MP- relay chain for outgoing senders is the same as for originating registers. If the intermediate MP- relay is operated the last MP- relay cannot operate because its operating battery is open. The first MP- relay can operate but will perform no function since its work contacts are open at the MP- relay of the intermediate circuit. The MP- relay which gains preference in the chain extends ground over the MON lead to completing marker to operate the MON relay of the completing marker (SFD-P212).

The SON relay (SFD-P112) operates from ground supplied through the MON relay and a sender group relay of the CM to the SON lead. The SON relay operates relay CMS (SFD-P114) to open the ground supplied to the MP- relay chain to operate the MON relay of the CM (SFD-P212). This ground is opened early so that, if the CM abandons the call before the MB- relays operate, a second marker cannot operate its MON relay. The SON relay locks through normal contacts of relay MSR1 so that, once the AMRST is seized on an outgoing sender call, it will advance to the point of operating the MB- relays to the completing markers for calls in progress before accepting new calls. When relay CMS operates to completing marker, the MM relay of the AMRST operates in series with the locking ground for the MON relay (SFD-P212).

The SON relay operates the ONM1 and ONM2 relays which serve as cut-in relays and also furnish general monitoring off-normal grounds. The ONM1 relay operates the TMA and TMB relays to start monitoring timing (SFD-P115). A ground is closed to prepare for advance of the monitoring allotter circuit, (progressive monitoring only). The MSR and MSR1 relays are operated at this time to simulate a call in case the AMRST is progressing to another type of call.

The SON relay also closes a resistance battery (SFD-P306) to the TRST lead to seize the MTFC. At the same time, the CM is proceeding to select an OS. A ground from relay SON through normal contacts of the SON1 relay and through the MON relay of the CM is extended to operate the M relay (SFD-P114) of the outgoing sender. Ground from relay SON on the SG lead to the outgoing sender operates DOS or MOS relay through the M relay of a dial pulse or multifrequency outgoing sender, respectively. The DOS or MOS relay operates relay SON1 (SFD-P112).

Assuming a dial pulse sender, the sender M relay locks through the DOS relay to ground through normal contacts of relay RN. The DOS relay connects ground to the SB lead to hold the SB relay (sender busy) operated at the conclusion of the call (SFD-P114). The DOS relay also operates relay DON to prepare for receiving dial pulses.

The MOS relay performs functions similar to those of relay DOS except that relay MFS operates in place of relay DON and prepares the AMRST to receive multifrequency pulsing.

When a trunk is connected to the OS, relay MAC1 operates from ground on the H lead from the outgoing sender (SFD-P108). The MAC1 relay operates relay MAC2 which locks and closes a locking path for relay SON (SFD-P112). The MAC1 and MAC2 relays establish a path for releasing the AMRST on abandoned calls. The SON relay is not locked to relay RN until the AMRST is prepared to operate relay RN on an abandoned call, relay SON1 opens the operating ground (OSM lead to completing marker) of the M relay of the OS. This is opened so that, if the CM route advances to

another OS, the M relay in the second OS will not operate. The general functions of relay SON1 are to indicate that an OS has been locked to the AMRST to control OS functions common to both monitoring and testing operation.

Outgoing sender monitoring is somewhat different from originating and incoming register monitoring in that at this time the MTFC is seized. The purpose is to register the information passed from the CM and through the CM to the OS. Since the originating register and incoming registers wait until the numbers have been pulsed, before seizing the master test connector frame, this action will be described in the P3 part.

P1-3.3 CONNECTION OF AMRST TO INCOMING REGISTER

After the progressive or circuit type (example: originating registers only) monitoring has been selected and the MAC and STM keys have been operated, as described in SCD P1-1 or P1-2, the AMRST is ready to connect to an IR.

When an IR is seized by an IRL, a ground is connected on the ON lead (SFD-P113). This ground is extended to operate the IRP- relay associated with that IR. The IRP- relays form a chain circuit which permits only one IR at a time to connect to the AMRST. This chain circuit includes an IRP- relay (SFD-P113) for each IR in the office regardless of type. If the intermediate IRP- relay is operated, the last IRP- relay cannot operate because its operating battery is open. The first IRP- relay can operate but will perform no function since its work leads are open at the operated intermediate IRP- relay.

The IRP- relay which gains preference in the chain operates the M relay of the incoming register (SFD-P110). The M relay connects leads used in monitoring to the AMRST. Ground from the IRP- relay is connected to the MB lead to hold the MB relay of the IR. On calls from bylink pulsing trunks to dial pulse incoming registers, ground will be connected to the BLG lead from the IRL through the IRP- and STM relays, to operate the BLM relay (SFD-P110). The BLM relay connects the pulse amplifier to the IR to receive pulses. An early operating path for the BLM relay is established since bylink pulsing may start very soon after the trunk is connected to the IR.

The IRP- relay operates the DIR or MIR relay depending, respectively, on whether the IR is dial pulse or multifrequency.

Whichever relay is operated closes a locking circuit for the preferred IRP- relay from ground through operated contacts of relay STM and normal contacts of RN relay (SFD-P113) and also operates relay IRN (SFD-P108).

The DIR and MIR relays serve as cut-in relays for the majority of the leads between the incoming registers and the AMRST.

The DIR relay operates relay DON (SFD-P108) to prepare the dial pulse counting circuit for receiving pulses. If a direct pulsing trunk is connected to the dial pulse incoming register, ground is connected to the SP lead after the start dial signal is completed and the pulsing path in the IR established. The SP ground operates relay DPM (SFD-P108) to connect the pulse amplifier to the register pulsing circuit. The DIR or MIR relays operate the AS, ASA, and MK relays (SFD-P211) to prepare the steering circuit for receiving the A digit.

The MIR relay operates relay MFR (SFD-P108) which establishes a path from the multifrequency incoming register through the MF amplifier to the multifrequency receiving circuit.

The IRN relay operates the ONM1 and ONM2 relays (SFD-P108) which serve as cut-in relays and also furnish general monitoring off-normal grounds. The ONM1 relay operates the TMA and TMB relays to start monitor timing (SFD-P115). The ONM1 relay also closes a ground to prepare for advance of the monitoring allotter circuit, (progressive monitoring only). The ONM2 relay operates the ONR relay to provide off-normal grounds for digit steering and digit registration. The MSR and MSRL relays are operated at this time to simulate a call in case the AMRST is progressing to another type of monitoring (SFD-P108).

Ground on the H lead from the incoming register (SFD-P108) will operate relay MAC1 which operates MAC2 relay to prepare the AMRST for recognizing abandoned calls. Ground on the MST lead operates relay RPS1 which serves as a register off-normal relay since it operates for both incoming and originating register calls. The RPS1 relay opens the operating path of relay SON to prevent this relay from operating if the call is extended to an OS. The RPS1 relay also closes the operating path for relay RPS1 but the RPS1 relay remains normal at this time due to a shunting ground on the MST lead.

P1-4 MONITORING A PARTICULAR CIRCUIT

The following paragraphs describe how the AMRST selects and connects to a particular originating register, outgoing sender, or incoming register.

P1-4.1 MONITORING A PARTICULAR ORIGINATING REGISTER

Before starting this type of monitoring, the AMRST must be normal. The MAC key is operated and the tubes of the amplifier permitted to heat for at least one minute. The MPOR key is now operated, followed by the STM key which operates the STM relay in turn operating the STM1 relay. The STM1 relay performs its off-normal functions as previously described. In this type of monitoring, the MP- relay chain and the OR, MBN, and MB- relays are not used. The Master Test Control (MTC) circuit is used to establish a dial tone connection from the originating test line to the

desired OR. At the time the DTM is connected to the OR, ground from the AMRST is extended to the MTC on the M lead and then through the MTFC, through the DTM and the trunk link and connector circuit to operate the M relay of the OR (SFD-P114). The M relay connects the OR to the AMRST as for a monitored call. When the OR seizes the AMRST, the CMS relay operates. The CMS relay locks to STMI and opens the M lead to the MTC to prevent operating other originating register M relays if the MTC is used subsequently. A ground from STMI through the MPOR key is supplied to the LK lead to the originating register to lock the M relay operated. The M relay is also locked operated under control of the DOR and RN relays at this time. The call to the OR is now abandoned and the OR and AMRST release. However, the STM, STMI, and CMS relays of the monitor and the M relay of the originating register remain operated. All succeeding calls received by this OR will be monitored. Ground from relay MSRI through the MPOR key to the MB lead to the OR makes the OR busy at the completion of a monitored call until the AMRST is restored to normal.

P1-4.2 MONITORING A PARTICULAR OUTGOING SENDER

Before starting this type of monitoring, the AMRST must be normal. The MAC key is operated and the tubes of the amplifier permitted to heat for at least one minute.

In this type of monitoring, the MP- relay chain and the OS, MBN, and MB- relays are not used. The desired OS is chosen by setting the SG switch at the number of the outsender group in which the OS is located and setting the SRS switch (SFD-P112) at the number corresponding to the number of the OS in that group, or, by operating the SG- key associated with that outsender group and a numerical unit of the SRS key corresponding to the number of the OS in that group. An SG relay is provided for each group of outgoing senders comprising a marker sender group, these outgoing senders being all of one type such as dial pulse or multifrequency. The MON- lead associated with a particular OS is wired to the position that the OS occupies in an outsender connector.

The MPOS key is now operated, followed by the STM key which operates the STM relay (SFD-P108) and in turn the STMI relay. These relays perform their off-normal functions as previously described. The SG- relay now operates through the STMI relay and the MPOS and SG- key or SG switch (SFD-P112). The SG relay in combination with the SRS switch or the SRS key connects the MON- lead of the selected OS through the STM relay to ground through the MM relay (SFD-P212). When a CM selects this OS, ground on the MON- lead will inform the CM that it is a monitored call and the CM will operate the M relay (SFD-P114) of the OS to connect the OS to the AMRST and start normal monitoring operation of the CM, OS, and

AMRST. Ground through the STM1 and STM2 relays (SFD-P108,P109), and the MPOS key is connected to the LK lead to the OS to lock the M relay of the OS. With the M relay held operated between calls, it is possible to hold the outgoing sender busy over the SB lead at the conclusion of a call until the AMRST has restored to normal as evidenced by the release of the MSR1 relay.

Each call that is now connected to this OS will be monitored. There is a possibility that a CM may be connected to the outgoing sender at the time of the operation first described and that a false trouble record by the AMRST on that call may result. To prevent this, the OS should first be plugged busy, the foregoing key operations can then be performed after an interval sufficient to permit completion of any call in progress. The busy plug can then be removed.

P1-4.3 MONITORING A PARTICULAR INCOMING REGISTER

Before starting this type of monitoring, the AMRST must be normal. The MAC key is operated and the tubes of the amplifier permitted to heat for at least one minute.

The desired IR is chosen by setting the IRG SEL switch (SFD-P112) to the position number of the incoming register group and setting the SRS switch (SFD-P113) to the number corresponding to the incoming register number in that group or, by operating the IG- key (SFD-P112) associated with the incoming register group and a numerical unit of the SRS key (SFD-P113) corresponding to the number of the IR in that group.

The MPIR key is then operated, followed by the STM key which operates the STM and in turn the STM1 relay. These relays perform their off-normal functions as previously described. The STM1 relay also, through the MPIR key, operates the SPR- relays (SFD-P112). These relays open the monitor start leads "ON-" for all incoming registers (SFD-P113).

The PC- relay now operates through the operated SPR- relay to which the IRG SEL switch is set or for which the IG- key is operated. The IRG SEL switch or the IG- key are wired so that only one PC- relay can be operated. The PC- relay operates the PCA- relay. The PC- and PCA- relays close only the ON- lead of the select incoming register link to the associated IRP- relay. The PCA- relay also closes a circuit to operate all RBN- relays. These relays operate all IRB- relays. When all the IRB- relays have operated, the IR relay (SFD-P109) operates and locks to STM1 relay through the MPIR key.

The IR relay operates STM2 relay which releases all RBN- relays. If the IR selected for monitoring is busy, its IRB- relay will be held operated by ground on the ON- lead from the IRL. When the IRB- relay has released and the IR is seized by the IRL, a subsequent ground on the ON- lead will operate the associated IRP- relay to battery supplied from the IR relay. This will cause that call to be monitored. Any succeeding calls to that register will be monitored similarly.

P1-5 TIMING (SFD-P115)

For each monitored call a signal timing interval of 40 to 70 seconds is provided. The details of the timer functions are explained in the following paragraphs.

P1-5.1 REGISTER TIMING

When ONM1 relay operates at the start of a monitored call, it operates TMA. The TMA relay removes the TM2 resistor shunt from the TM capacitor and connects ground through the TM relay to the capacitor. The TM capacitor starts to charge in series with the timing resistor TM3. With the TM capacitor discharged, the 1 to 4 control gap of the TM tube will have no potential applied across it. As the capacitor charges, its voltage will be applied across the control gap. When the charge has reached approximately 70 volts, the tube will ionize across its control gap and current will then flow in the main gap to operate the TM relay. The value of the TM capacitors and TM3 resistor have been chosen so that the capacitor will charge to the ionization potential in from 40 to 70 seconds. Since the register timing is maximum 35 seconds, the register will have a chance to timeout and restore to normal before the AMRST times out. This prevents the AMRST from timing out on partial dials.

P1-5.1.1 Timing During Pulsing

When TMA operates, it locks on its secondary winding to off-normal. The TMB relay operates through TMA contacts to the same ground and opens the operate circuit of TMA. For dial pulse registers (OR and IR), the locking ground for TMA is supplied from the RAL relay through break contacts of PEA and make contacts of ONM1. The RAL relay releases at the start of pulsing of each digit and releases TMA and TMB. The TMA relay closes the TM2 resistor around the TM capacitor discharging it. The TMB relay releasing closes a reoperate path for TMA. The TMB relay is slow-release to permit complete discharge of the capacitor before TMA reoperates to restart the timing. When RAL reoperates at the end of a digit, TMA locks and TMB operates. This cycle repeats as each digit is received.

For multifrequency incoming registers, locking ground for TMA is supplied directly from the MIR relay. This provides no recycling of the IR during dialing.

For TOUCH-TONE originating registers, locking ground for TMA is supplied through TMC. A contact of TMC is used, rather than of STRA, because a keyed digit of short duration may not recycle the TM timer (if the STRA contact were used) since TMA may not release before its lock path were established. The TMB relay is guaranteed to release after TMA. Since TMC cannot reoperate until TMB is released, the TM timer will definitely recycle on every digit.

Pl-5.1.2 Timing for Marker Seizure

When the register started to seize a marker, PEA of the AMRST operated (SFD-P212). The PEA relay releases TMA and TMB to recycle the timer as previously described. When TMB releases, it closes a circuit to operate TM2 from make contacts of PEA. The TM2 relay locks directly through PEA and closes a ground to lock TMA and operate TMB. The TM2 relay also substitutes resistance TM4 to reduce the interval to 10 to 17-seconds. In this case the timing interval is made less than the 20 second minimum time of the register timers. This permits the AMRST to make a trouble record if a register fails to get a marker due to a trouble such as an open start lead. No register alarm would be obtained under this condition since the register releases itself after a timeout.

If the numbers do not match, TRR2 will operate. The TRR2 relay releases TMA and TMB. The TMA discharges the timing capacitor. When TMB releases, TMA operates to start a 10- to 17-second timing interval for completion of the trouble record.

Pl-5.1.3 Time out Trouble Record

If the TM tube ionizes, the TM relay operates. The TM connects ground to the MN lead to the master test frame jack, lamp, and key circuit to light a trouble lamp and sound a minor alarm. The TM relay also operates TM1 which locks. The TM1 relay releases TMA and TMB. The TMA relay discharges the TM capacitor and releases TM which permits TRR1 to operate and lock. When TMB releases, TMA and TM2 operate to start a 10- to 17-second timing interval which covers the trouble record and releases operation of the AMRST. The TM2 relay will already be operated at the time of this recycle if the call has progressed to the point of selecting the marker. The TRR1 relay causes a trouble card to be perforated as described for originating registers and outgoing senders. The information on the card will depend on how far the call has progressed. If there is a time-out after TRR1 operates, DL relay will operate from TM. This is also true if TRR1 has operated as the result of a number mismatch. The DL relay locks to battery on the DLB lead from the master test frame jack, lamp, and key circuit and closes ground to the DL lead to that circuit to light a lamp indicating that a trouble record was attempted but not completed. The DL relay also closes ground through TRR1 to operate TRC which locks and restores the AMRST to normal. If the trouble recorder is out of service or plugged busy to the AMRST, the MTFC will connect ground to the TRB1 lead. When TRR1 operates to start a trouble record, the DL relay will operate from

this ground immediately and function as just described. With the recorder out of service, the hold feature can be used to trace register troubles. When TMI operates on a time-out, it grounds the SCT lead and removes ground from the MON1 lead to the marker. This action permits the marker to complete its functions and release without any interference from the AMRST. This feature is provided to cover the remote possibility that the AMRST might time out while connected to the marker and leave it unable to complete its functions.

P1-5.2 OUTGOING SENDER TIMING

Timing is started by ground from ONM1 which operates TMA. The TMA relay locks and TMB operates to ground through make contacts of SON through break contacts of PEA and make contact of ONM1. This is a 40- to 70-second timing interval and covers completion of monitoring on a call on which no trouble is found.

If the numbers do not match, relay TRR2 operates and releases relays TMA and TMB. When TMB releases, TMA and TM2 operate to start a 10- to 17-second timing interval to cover the trouble record.

The operation following a time out is the same as described in "Time Out Trouble Record" for registers (P1-5.1.3).

SECTION P, PART 2

PULSE RECEIVING

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P2 PULSE RECEIVING

When the AMRST has been connected to an originating register, outgoing sender, or incoming register, it prepares itself to receive the pulses of that circuit. The following paragraphs describe the pulse receiving details of:

(a) Originating Register Monitoring

After the AMRST has been connected to the Originating Register (OR) via operation of the register M relay, the AMRST prepares itself to accept pulses. The pulses are received at a high impedance so as not to interfere with the pulses being received by the OR. The pulses are received in the AMRST where they are counted and stored.

(b) Outgoing Sender Monitoring

After the Outgoing Sender (OS) receives the start pulse signal, the digits already stored in the OS are now outpulsed into the AMRST where they are received at a high impedance so as not to interfere with the outpulsing performance of the OS over the loop to the distant office. The pulses are received by the AMRST where they are counted and stored.

(c) Incoming Register Monitoring

After the AMRST is connected to the Incoming Register (IR) via its M relay, the AMRST prepares to accept pulses. These pulses are received at a high impedance so as not to interfere with the pulse receiving of the IR.

The pulses are received by the AMRST where they are counted and stored.

P2-1 DIAL PULSE RECEIVING (SFD-P207)

The following paragraphs describe how the AMRST repeats, counts, registers and steers the dial pulse digits. Dial pulse digits can be received when monitoring originating registers, outgoing senders and incoming registers.

When monitoring dial pulse originating registers, dial pulses generated by the calling subscriber are received simultaneously by the OR and AMRST. Once the OR is connected to the AMRST via the M relay, the ORM relay operates connecting the Dial Pulse Amplifier and Repeater of the AMRST to the OR. The pulses generated by subscriber dialing are then counted and stored by both OR and the AMRST (SFD-P207).

When monitoring dial pulse outgoing senders, dial pulses generated by the OS are received by the distant office and the AMRST simultaneously. Once the OS is connected to the AMRST via the outgoing sender M relay, the DSM relay operates connecting the Dial Pulse Amplifier and Repeater of the AMRST to the OS. The dial pulses generated by the OS are then counted and stored by both the distant office and the AMRST (SFD-P207).

When monitoring dial pulse incoming registers, dial pulses generated by the distant office are received simultaneously by the IR and the AMRST. Once the IR is connected to the AMRST via the incoming register M relay, the DPM relay operates connecting the Dial Pulse Amplifier and Repeater of the AMRST to the IR. The pulses generated by the distant office are then counted and stored by both the IR and the AMRST (SFD-P207).

P2-1.1 DIAL PULSE AMPLIFIER REPEATER AND BIAS CONTROLLER (SFD-P206,P207)

The dial pulse amplifier repeater and bias controller circuit is used to repeat dial pulses incoming to originating and incoming registers and outgoing from outgoing senders. This circuit in conjunction with the L relay performs the functions of the L relay in the originating and incoming register circuits or pulsing relay at the terminating end of the trunk outgoing from the OS. In order that these functions be performed without interference to the pulsing relays in the service circuits, the connection is made to them with a high input impedance circuit. Since the high impedance circuit does not pass sufficient power to operate a relay directly, an amplifier is used to transform voltage changes occurring across selected portions of the service circuit during pulsing into changes in power of sufficient magnitude to operate a pulse repeating relay.

During pulsing into a register, current flows through a winding on the L relay and two windings on the tone coil when the dial contact is closed, with little or no current flowing when the dial contact is open. The voltage across the tip and ring, therefore, varies from a value which is less than the office battery voltage (by an amount of the voltage drop in windings of the L relay and tone coils) to a value approximately equal to the office battery, respectively. In order to operate on the change in voltage across tip and ring obtained during pulsing, a counter or bias voltage must be provided in the circuit connecting the amplifier to the register to offset the office battery potential and to provide a positive bias for the amplifier tube. Office battery voltage cannot be used to provide the bias voltage directly since it may vary over wide limits. Means are therefore provided for supplying an ungrounded biasing voltage with the magnitude controlled by the potential of the office battery.

Means are also provided to alter the bias voltage when monitoring originating registers in accordance with the resistance of the connected dialing loop. The control for this bias adjustment is obtained from the voltage drop obtained across the tone coil winding on the tip. The change in bias is made to assist in eliminating double pulsing from oscillations set up when pulsing under certain line conditions.

The conditions obtained during pulsing for an OS are different from that for registers. The voltage drop across the contact or contacts controlling pulsing is zero or less (potential reversed) when the pulsing circuit is closed. When the pulsing circuit is opened at the OS, the voltage across the tip and ring rises to the value of the office battery potential at the distant office. The voltage to ground from either conductor may be altered by ground potential conditions existing between offices. To meet these conditions, an amplifier, ungrounded except for the paths obtained over tip and ring and with a fixed bias of moderate value, is used.

To prevent recording as a legitimate pulse a surge occurring due to switching conditions in PBXs and DSA boards, a timed delay circuit is used. This delay is provided by the DP tube circuit (SFD-P207). Pulses shorter than its timed value are rejected.

To assure obtaining a closure of adequate length for operating register relays in the AMRST, the L relay is operated from the P relay (SFD-P213) and the L relay when operated will remain operated for a timed period due to the action of the capacitor in its secondary winding circuit. A capacitor timed relay is used as the RAA relay to assure holding on very slow pulsing.

P2-1.1.1 DC and AC Power Supply (SFD-P206)

Two ungrounded sources of dc power, in addition to ac for the heaters of the vacuum tubes, are required for the circuits mentioned above. An ungrounded source of dc power is required owing to the operation of the amplifier circuit at a potential above ground determined by the conditions in the monitored circuit. The second ungrounded dc supply supplements the +130 volt office battery potential. The amplifier is sensitive to small changes in dc voltage; hence, it is necessary to regulate the rectified ac supplied to it which may vary from the nominal value by +10 percent. A connection is made from the ac supply to the transformer tap corresponding to the nominal supply voltage.

The R electron tube rectifies the high voltage ac from the B transformer. A filter R1A (retard coil and R11 and R12 capacitors) reduces the ripple in the dc voltage supply to the PA and DP electron tubes (SFD-P207). The dc voltage at the output of the filter fluctuates as the RMS value of the ac supply voltage fluctuates. The VR2 and VR3 gas filled voltage

regulator tubes and the VR4 resistor are connected in series across the dc supply at the output of the filter. The current through the tubes and resistor will vary as the voltage fluctuates, but the voltage drop across the the voltage regulator tubes VR2 and VR3 will remain substantially constant due to the characteristics of the tubes. This property is used as described in a later paragraph. The load current is passed through a circuit consisting of the VR1 electron tube and the VR1 resistor in parallel.

The grids of the VR1 tube are connected to the VR2 tube. So long as the VR1 tube operates between saturation and cutoff, voltage changes between grids and cathodes of VR1 tube will be at a minimum. For instance, if the rectified dc voltage should go up, the dc potential at the cathodes would tend to go up. Since this would cause the grids to become more negative with respect to their cathodes, the current flowing through the VR1 tube is reduced and a greater proportion of the load current will flow through the VR1 resistance which is in parallel with the VR1 tube. The potential across the load increases and the cathode voltage will therefore tend to remain at approximately the original value or very nearly that obtaining across the VR2 and VR3 voltage regulator tubes.

The P gas filled tube and B fuse are provided in order to prevent a dangerously high voltage from being connected to leads external to this circuit in the event that the high-voltage section, dc, ac, or the amplifier power supply becomes grounded. In operation, the P tube will fire when the voltage to ground exceeds approximately 180 volts. The resulting current through the B fuse will cause it to operate and open the circuit.

Plate supply for the bias control circuit is obtained from the office +130 volt supply. In addition, a booster voltage for plate 4 of the B1 electron tube is obtained from rectified and filtered ac power. Grid bias for grid 3 of B2 electron tube is obtained from the office 48-volt battery through a voltage divider.

The ac power is connected to the primary of the ac transformer through contacts of the AC relay which is under control of the MAC key. The MAC key when operated also closes a circuit from the break contact of the NVA relay to the alarm circuit. The NVA relay is operated from rectified ac and is held operated as long as ac is connected. The release of the NVA relay, owing to operating the AC fuse or a power failure, will therefore operate an alarm. The control circuit for the start monitor relay in the monitor control circuit is closed through a make-contact of the NVA relay. Releasing the NVA relay therefore prevents the monitoring operations from starting or continuing.

P2-1.1.2 Bias Control Circuit (SFD-P206)

The ungrounded biasing potential for the amplifier is obtained from a rectified ac signal. The magnitude of the ac is controlled through an amplifier by a dc voltage which is a fixed amount below (less negative than) the office battery potential and which changes in potential as the office battery potential changes. A change in the office battery voltage will be reflected by a change of the same magnitude in the dc bias voltage.

In this circuit, the VR4 gas filled voltage regulator tube with series resistor VR9 is connected between the positive 130-volt office supply and the negative reference voltage. The VR9 resistor limits the current which will flow, and the VR4 tube maintains a virtually constant voltage drop across its terminals. A voltage divider circuit is connected across the VR4 tube. This consists of the RB1, VR10, VR11, and RB2 resistors and the B1 potentiometer connected in series. The slider of the potentiometer is connected through a filter circuit, a rectifier circuit and a resistor to grid 7 of the B1 electron tube. The V5 resistor and B1 capacitor serve as a filter circuit for preventing low ac voltages superimposed on the office battery supply from affecting the operation of the bias control circuit. The rectifier supplying grid 7 of control tube B1 is a duplicate of the rectifier supplying the bias voltage for the pulse amplifier PA tube (SFD-P207). A 540 cps signal for the two rectifiers is obtained from duplicate windings on the B transformer. If the office battery voltage becomes more negative, grid 7 of the B1 tube will become more negative, cutting off plate 6 slightly. The voltage on plate 6 will rise slightly, raising grid 3 voltage on the B1 tube and allowing a larger amplification of the signal appearing at grid 3 of the B1 tube from the tone supply over lead HT3. The amplified signal appearing at plate 4 of the B1 tube is further amplified at plate 6 of B2 tube, and appears on the primary windings of the B transformer. This larger signal provides a larger rectified output at both the V1 to V4 rectifier and at the V5 to V8 rectifier (SFD-P207). The magnitude of this increase is slightly less than the change in office battery. The result is a slightly more negative bias voltage (appearing at grid 7 of B1 tube) which maintains a sufficient corrective voltage at rectifier V1 to V4 to overcome the office battery change. A similar sequence of events occurs if the office battery becomes less negative.

Means are provided for shunting the V1 to V4 rectifier output with a proper resistance to offset the differences in the two rectifiers and make the change in rectifier output the same for both with a given change in the input ac voltage. The error voltage which corrects the dc bias voltage at grid 7 of the B1 tube is less than 0.1-volt for change of 5 volts in the office battery voltage.

To illustrate the operation of the circuit, typical voltages in the circuit during a corrective action will be given. Suppose the office battery voltage was initially -47 volts, and the voltage across the V1 to V4 rectifier was 32 volts. Let us assume that the office battery voltage becomes 5 volts more negative in a matter of 3 or 4 seconds. After the office battery change, the office battery will be -52 volts and the rectifier output voltage will increase slightly less than 5 volts to a value of 36.9 volts.

P2-1.1.3 Originating Register Connection (SFD-P207)

The ORM relay is operated, as described in P1-3.1, when an OR is connected. This relay, in operating, closes leads from the amplifier grid and the amplifier biasing circuit to the ring and tip respectively of the line connection in the OR (SFD-P207). The incoming register bias relay IRB is normal at this time (SFD-P206). The amplifier bias is altered by the bias circuit in accordance with line conditions as will be described later.

The bias voltage is of sufficient value to produce a small negative or positive voltage difference between grid 7 and cathode 8 of PA electron tube with the customers loop closed. Under this condition current flows through plate 6 of the PA tube and through the PA4 resistor. The voltage obtained on plate 6 and grid 3 of the PA tube connected to it is therefore lowered. The drop across the PA4 resistor is sufficient to reduce the voltage at grid 3 of the PA tube in relation to that obtained on cathode 2 to a value where the current flow between cathode 2 and plate 4 of PA tube is cut off. When the loop is opened by the dial, the current flow in the line drops to zero and the voltage on the ring conductor rises to the potential of the office battery. The voltage on the tip conductor drops to ground potential owing to the reduction in current through the tone coil. The voltage obtained on the ring under this condition is sufficient to offset the amplifier bias and produce a negative voltage on grid 7 with respect to cathode 8.

This decreases the current flowing in plate 6 and increases the potential on grid 3. Current flows between cathode 2 and plate 4. The DP tube operates when this occurs and reduces the potential at plate 4 of the DP tube. This condition is maintained for a timed interval. At the end of the timed interval, if grid 3 is still at the value for obtaining conduction between cathode 2 and plate 4, current will flow and relay P will be operated. The P relay in operating operates the pulse corrector relay L in the AMRST (SFD-P213). The L relay operates and holds operated the CDP relay. The CDP relay opens the operating circuit for the DP electron tube. This prevents the DP tube from delaying the release of the P relay if it releases during a pulse period. At the end of the open period, the voltage obtained across the tip and ring will return to normal and the P, L, and CDP relays will release. This cycle of events is repeated on each pulse.

The DP tube functions as a monopulser to mask short impulse noise which appears on the line. That is, a definite cycle of events will be started by a negative transition from plate 4 of the PA tube, at the end of which the circuit will return to normal and remain in this condition until the next negative transition is received. At the beginning of a dial pulse, plate 6 of the PA tube turns off, plate 4 of the PA tube turns on, and the negative voltage transition at plate 4 of the PA tube is coupled to grid 7 of the DP tube to start the monopulser action. After a time interval, the DP tube will return to normal and remove the shunt from the P relay. If the customer line is still open as a result of the dial pulse, the removal of the shunt by the DP relay will allow the P relay to operate through resistor P2.

The details of the above timing are as follows: Under the normal condition, current flows in the circuit consisting of cathode 8, plate 6 of DP tube and common cathode resistor DP1A. Plate 6 of the DP tube is connected to grid 3 of the DP tube through a voltage divider circuit. This holds the grid at a negative potential with respect to its cathode 2, under normal conditions. No current will flow in the DP tube at this time. Plate 4 of the DP tube is connected through a capacitor DP1, and resistor DP2A to cathode 8 of the DP tube. The midpoint of this circuit is connected to grid 7 of the DP tube. A voltage change at plate 4 at the DP tube is transmitted directly to grid 7 of the DP tube through capacitor DP1. If the voltage change drives the grid negative, conduction will drop in the cathode 8 plate 6 circuit of the DP tube. The change in voltage at plate 6 of DP tube will cause grid 3 of the DP tube to become positive with respect to its cathode. Current will then flow in the cathode 2 plate 4 circuit of the DP tube. Grid 7 of the DP tube will remain negative with respect to its cathode 8 until the capacitor DP1 becomes charged through the series resistor. The DP2 with a time constant of about 3 ms will then restart in the cathode 8 plate 6 circuit of the DP tube. The change in potential on plate 6 when current starts to flow will be reflected by a decrease in potential on grid 3 of the DP tube. This will stop conduction in the cathode 2 plate 4 circuit of the DP tube, thereby restoring the multivibrator circuit to normal.

If the PA tube continues in the conduction condition, the DP tube will remain in the normal condition. If, however, plate 4 of the PA tube had been quickly turned on and off by a short noise voltage on the line, PA tube will return to normal before the end of the monopulser timing period, preventing P relay from operating. Capacitor DP1 quickly charges to its normal state through a path consisting of grid 7 cathode 8 of the DP tube in parallel with resistor DP2A.

P2-1.1.3.1 Bias Compensation Due to Loop Variation (SFD-P207)

The voltage change which occurs across the tip and ring of the line during pulsing is dependent on the resistance in the loop. The greater change occurs with short loops. This permits a reduction in the amplifier bias

to be made when the connected loop is of low-resistance. Such a reduction is required on some short loop conditions in order to prevent splitting dial pulses. Corrections in bias voltage with changes in pulsing loop are controlled by the B2 tube (elements 2, 3, and 4) and associated circuit. The B2 tube in turn is controlled by the voltage drop across the tone coil in the OR. This voltage will vary inversely to the resistance of the connected loop. That is, with a short loop the voltage across the tone coil will be large, and, with a long loop, it will be small. When the loop is opened during pulsing, this voltage drops to zero. It is during this period when the voltage is zero that compensation is required; hence, a memory circuit is used for retaining a condition which is based on the normal condition. The memory circuit consists of the B5 capacitor, which is charged to the voltage obtaining across the tone coil winding in the period before pulsing starts. The charging circuit is nonbilateral (resistance not the same in the two directions of conduction due to the use of the B2 diode in this circuit; therefore, the charge will be built up rapidly on the capacitor but will be dissipated at a reduced rate). Grid of the B2 tube is normally biased in such a way that no current will flow in the B2 tube until the potential on the memory capacitor exceeds the turnon value. The bias voltage is obtained from the office battery by using a voltage divider. The divider consists of resistors B10 and B11 in series with potentiometer B2. Any increase in voltage at grid 3 of the B2 tube due to the office battery becoming less negative will be counterbalanced by the voltage drop across resistor B7 in the cathode 2 circuit of B2 tube. The cathode resistor is also in the input circuit for the amplifier hence potential drop across it will alter the effective bias of the amplifier.

To illustrate the above corrective action, typical voltages will be given under short loop and long loop conditions. The plate 4 circuit of the B2 tube has a load resistance of approximately 2,200 ohms (B7 resistor in series with the tone coil of the OR). Assume potentiometer B2 is set at its midpoint. The voltage appearing at the slider of potentiometer B2 is approximately -11 volts. Due to some drop across B9 resistor and B2 diode, the voltage appearing at the grid 3 of tube B2 is about -13 volts. First assume the OR is serving a customer on a short loop (zero ohms). The voltage appearing at the tip to the AMRST is about -22 volts. The B2 tube turns on, allowing current to pass through the B7 resistor. The resulting voltage at cathode 2 is -11 volts, which is passed through a make contact of ORM to the V5 to V8 rectifier, tending to cut off the PA tube by raising the voltage on its cathode and make it less sensitive to the large swings of the dial pulses.

Now assume the register is serving a customer on a longer loop (1500 ohms). The voltage appearing at the tip to the AMRST is about -4 volts. The B2 tube turns off, preventing current from passing through the B7 resistor. With no voltage drop in B7 resistor, the tip voltage is passed to the V5 to V8 rectifier, tending to turn on the PA tube and making it more sensitive to the small swings of the dial pulses.

P2-1.1.4 Incoming Register Connection (SFD-P207)

The IR is arranged to record dial pulses which are received in either one of two ways: one method is similar to that of the OR; the other method, which is used on calls from step-by-step offices, operates from a pulse repeater in the trunk circuit.

The DPM relay is operated when a connection is made to an IR in which the L relay in the IR is connected to the trunk conductors during pulsing. The DPM relay connects the grid circuit of the PA amplifier tube to the ring trunk conductor in the IR and connects the cathode circuit of the PA amplifier tube through the biasing circuit for the amplifier to the tip trunk conductor in the IR. A higher bias voltage is required than is used with the OR owing to the longer loops involved and, hence, the small voltage change which occurs during pulsing across the line winding of the L relay and the tone coil windings that are in series with the trunk. This change in bias is obtained by operating the IRB relay before monitoring on incoming registers is started and holding it until monitoring on this type of register is completed. The IRB relay is operated from the common control circuit before monitoring on incoming registers is started (SFD-P109). The IRB operated opens the short circuit around the RB1 resistor (SFD-P206) and closes a short circuit around the RB2 resistor. Both of these resistors are in the voltage divider circuit at the input to the bias control circuit. The shift in resistance changes the input voltage to the V1 to V4 rectifier to a higher negative value. The bias control circuit acts to change the amplifier bias by a like amount.

The circuit functions in the same manner as it does with originating registers. A detailed description of the operation is given under originating register connection (P2-1.1.3).

The BLM relay (step-by-step operation) is operated (SFD-P110) when a connection is made to an IR used with a trunk which repeats the dial pulses. This is known as bylink operation. When operated, the BLM relay connects the tip and ring leads into the register as the DPM does in the other type of IR for preparing the register circuit for receiving pulses.

The operation of the AMRST amplifier is similar to that described before except that the L relay is operated in the local circuit over the ring conductor and the tip circuit beyond the tone coil ringing is open. Voltage changes for operating the AMRST amplifier occur on the ring conductor side only.

P2-1.1.5 Outgoing Sender Connection (SFD-P207)

Dial pulsing out of an OS is done in one of three ways:

- (a) Slow speed loop pulsing.
- (b) High speed loop pulsing.
- (c) Battery and ground pulsing.

The connection to the AMRST amplifier and the operation of the amplifier is the same for all three pulsing conditions. The connection of the two control leads to the amplifier are made across the tip and ring leads on the trunk side of the pulsing contact or contacts in the sender. An ungrounded amplifier is required in this case in order to eliminate earth potential effects on the amplifier operation. The potential existing across the tip and ring will vary during pulsing from zero or a positive voltage (ie, potential on the ring less negative than the tip potential) with the loop closed, to full battery voltage when the loop is opened. The battery voltage is that existing in the distant office. Since the rate of change in voltage is reduced by the capacity between trunk conductors and to ground, the voltage across the tip and ring OS the sender may not reach full battery potential during an open period. The biasing voltage for the amplifier is therefore kept low, approximately 15 volts. This bias voltage is obtained from a voltage divider across the VR3 voltage regulator tube.

The connection to the sender is established by operating the DSM relay (SFD-P108) from the AMRST control circuit which connects the T lead from the OS to the biasing circuit and the R lead from the OS to the control grid of the amplifier. The operation of the amplifier circuit during pulsing is the same as for originating registers. A detailed description of the operation is given under originating register connection P2-1.1.3.

P2-1.1.6 Adjustment of Bias (SFD-P207)

Provision is made for connecting the AMRST amplifier to a test voltage under control of a key.

An adjustment of the bias voltage can be made such that the P relay will just operate. Operation of the P relay is indicated by the AAB lamp signal (SFD-P206). Operation of key AAB closes a circuit for operating relay AAB (SFD-P207). The AAB relay in operating:

- (a) Connects the amplifier input to a test potential obtained from the voltage divider formed by resistors AAB1 and AAB2 connected across the reference voltage supply leads.
- (b) Connects the make contact of the P relay to the AAB lamp (SFD-P206).
- (c) Closes a circuit for operating IRB relay (SFD-P109).

The B1 potentiometer (SFD-P206) is then moved to a position where the AAB lamp is extinguished if it was lighted when the AAB key was operated. The B1 potentiometer slider is then slowly rotated in the direction for operating the AAB lamp. Adjustment is continued until a point is reached where a slight change in either direction will operate or extinguish the lamp. The potentiometer slider is left in this position.

P2-1.1.7 Checking Operate Time Delay of P Relay (SFD-P207)

The AAB key is operated, closing the input circuit of the amplifier to a test potential. A connection is made from the timing test set through the TTS jack to the voltage divider circuit. This consists of the TTS capacitor, TTS1 and TTS2 resistors connected in series through an operated contact in the AAB relay between plate 6 of the DP tube and the 48-volt office battery. The operating circuit for the AMRST amplifier is transferred to the timing test set by a plug in the TTS jack. A measurement is made from the timing test set by closing the operating circuit to the AMRST amplifier and noting the length of time that no current flows in the plate 6 circuit of the DP tube. This time should be approximately 10 ms.

P2-1.2 DIAL PULSE COUNTING (SFD-P213)

During pulsing, the pulses are received by the dial pulse amplifier and repeated by the P relay in the amplifier circuit to the dial pulse counter consisting of the P- relays. Operation of the amplifier is described in Dial Pulse Amplifier Repeater and Bias Control (SFD-P206, P207).

When the STM key is operated, AON operates (SFD-P108) and furnishes off-normal ground to bias the L relay to its break contact. Ground through this break contact operates the LA relay. The AON relay also biases RAA to its break contact. When LA operates, it operates LA1 which closes the break contacts of LA to the RAA relay and its associated capacitor. Closure of this path is delayed until LA operates to prevent RAA from operating prematurely when AON first operates. If RAA operated, it would be held operated for approximately 0.1 second by the RA capacitor, thus causing trouble if the monitor was seized quickly. The RAA armature is controlled from LA1 to prevent interference with the adjustment of the LC relay if RAA lies on its make contact when its biasing winding is open.

When the AMRST is seized, DON operates from DOR (SFD-P108). The DON relay closes leads to permit control of the steering circuit of the register. The DON relay also closes the control leads for the PST relay and connects ground to start AMRST timing (SFD-P115). The operation of the AS and ASA relays associates the A digit register relays with the output of the dial pulse counter. The circuit now awaits pulsing.

The L relay follows pulses received from the P relay and transmits them through the CDP relay to the LC, LD, and LE relays. When L operates, it releases LA which closes a circuit to operate the RAA relay on its secondary winding and discharge the RA capacitor. When LA reoperates as L releases at the end of a pulse, the RA capacitor will charge through the RAA relay holding it operated until the charging current decreases to the point where the bias current in the primary winding releases the

relay. The circuit elements in the bias and charging circuit paths have been so chosen that the RAA relay will just hold over the longest open period between pulses. It is held to close time tolerances since, when it releases, the digit just pulsed must be registered and the circuit prepared to receive the next digit.

The RAA relay operating at the start of the first digit operates PST which locks to DON. The PST relay prepares a path for operating RAl at the end of the digit, recycles the timer and operates PH. The PH relay closes circuits used in registering the digit and advancing the steering circuit at the completion of a digit.

In order that the L relay will produce usable pulses at its contacts even though line conditions and central office voltage have wide variations, certain corrective devices have been added to the L relay and its associated circuit. These are described in the following paragraphs.

The L relay has no retractile spring but instead is provided with a tertiary winding energized in the direction to hold contact 5 closed, whereas the primary winding is energized in the direction to hold contact 4 closed. This partly compensates for battery voltage variations, and also causes the relay to release quickly when the primary winding is opened, since the releasing force does not decrease as the armature restores to normal as it would if a retractile spring were used.

The secondary winding and its associated circuit is provided in order to insure that the contact closure will not be less than a minimum time determined by the time constant of the secondary circuit. When contact 5 closes, capacitor LA1 charges in series with the secondary winding. The charging current is in the direction to hold the relay released, and the relay will be held released until the capacitor becomes sufficiently charged and the current reduced so that the magnetizing force of the secondary winding becomes less than that of the primary winding. When contact 5 opens, capacitor LA1 discharges in series with the secondary winding and the LA1 resistor. The direction of the current is such that the armature is held against its contact 4, at least for the time required for the capacitor to discharge and reduce the current sufficiently so that the secondary magnetizing force plus the tertiary magnetizing force becomes less than the primary magnetizing force. The secondary winding, therefore, causes the L relay to stay on whichever contact has closed, for a time long enough to perform the required functions, even though the contact closures of the P relay are short.

The LC, LD, and LE relays follow the make contact pulsing of the L relay and convert a closure and open of the L relay contacts into a single pulse to the counting relays. At the completion of a pulse cycle (which consists of a closure and open of the L relay make contact), these

relays transmit a pulse to one of two leads, used alternately to operate the P1 to P6 counting relays. The LC relay operates when L operates on the first pulse, and the LE operates by its primary winding in series with the LC when L releases on the open following this pulse to remove the shunt from the LE winding. The operating ground for LE is supplied from make contact of RAA. The LE relay operating closes a ground to one of the two operating leads for the pulse counting relays. When L operates on the second pulse, LD operates on its primary winding in series with the secondary winding of LE. This holds LE since its original operating path is opened and LC is released by LD. When L releases at the end of the pulse, LD and LE release. The LE relay also removes ground from one of the counting relays operating leads and supplies it to the other. Any possibility of LD releasing before LC and thereby preventing the release of LC and LE is prevented by locking the secondary winding of LD to a make contact of LC. If more digits are received, this cycle will be repeated every two pulses of the digit. Upon the completion of a digit, the release of RAA will release LC and LE if they have been left operated by the reception of an odd number of pulses.

The pulses of each digit are counted on relays P1 to P6 which operate in rotation from alternate contact closures of LE. In general, each relay releases the previous relay except that P6, if operated, remains operated to indicate that a digit of more than five pulses has been received. At the completion of a digit the count is first transferred to the register relays over two out of five leads and then the operated counting relays are released in preparation for the next digit. The P6A relay is an auxiliary relay to the P6. The relays operated after each pulse are as follows:

<u>Pulse No.</u>	<u>Relays Operated</u>
1 LC, LE	P1
2	P2
3 LC, LE	P3
4	P4
5 LC, LE	P5
6	P5, P6, P6A
7 LC, LE	P1, P6, P6A
8	P2, P6, P6A
9 LC, LE	P3, P6, P6A
10	P4, P6, P6A

The first operation of LE operates P1 on its primary winding through break contacts of P2, P3, P4, P5 and RA1. The second pulse, through break contacts of LE and make of P1, operates P2 which releases P1 and locks itself through the same path which previously locked P1. The third pulse, through break contacts of P4 and make of P2, operates P3 which unlocks P2 and locks itself. This action continues until the sixth pulse operates P6

through make contacts of P5. The P6 relay operates P6A and locks for the remainder of the digit but does not unlock P5. The P1 relay operates and locks again on the seventh pulse, this time, though make contacts of P6 and releases P5. The eighth, ninth, and tenth pulses operate P2, P3, and P4 respectively, each relay as it operates unlocking the one ahead of it.

When the RAA relay releases upon completion of a digit, certain of the P relays will be locked to RA1. The break contact of RAA closes ground to two leads which are steered by the operated P1 to P5 relay and the P6A to the proper 2-out-of-5 leads to operate register relays. The release of the P- relays and the control of steering circuit by the PH and RA1 relays is described in a subsequent paragraph.

P2-1.3 DIAL PULSE DIGIT REGISTRATION AND STEERING (SFD-P211,P216,P217)

Five register relays and two steering relays are provided to accomplish the registration of each digit received from the pulse counting relays. The KA2/5-KL2/5 relays (SFD-P312) associated with register relays is used in checking the dialed number against the number received from the marker. The DL- relays and the steering and register relays preceding the A digit are used in connection with outgoing senders.

When the AMRST was seized, ground through ORN and ONR operated the AS, ASA, and MK relays (SFD-P211). The ASA relay connects the A(0,1,2,4,7) relays (SFD-P216) to the output of the pulse counting relays. The MK relay is slow-operate to permit AS to operate and lock through break contacts of BS to ONR before the operating path is broken by MK. The ONR relay provides general off-normal grounds and ORM1 prepares the checking circuit for originating register operation. The circuit now awaits the first digit.

As previously described, a circuit through the counting relays will operate two of the A(0,1,2,4,7) relays at the end of the A digit. Assuming, for discussion, a number other than 0, 1, 8, or 9 lock to ONR. The locking path for A0 or A1 is through make contacts of one of the other three operated relays. The RA1 relay (SFD-P213) operating at the end of a digit closes ground from make contacts of one of the other three operated relays. Also, the RA1 relay (SFD-P210) operating at the end of a digit closes ground from make contacts of the PH relay through AS and A2, A4, or A7 operated to operate BS and BSA (SFD-P211). Break contacts on RA1 (SFD-P210) also open the operating path of PH and close a locking path through break contacts of T0. The break contacts 1 and 3T on BS relay (SFD-P211) insures locking BS before its operating path is opened, the operating path being opened to prevent the locking ground from backing into the operating circuit. The 1 and 3B break contacts of the B5 relay opens the path by which AS and ASA were locked to off-normal ground and connects these relays to ground through the T0 relay and its T0 register shunt. The T0 relay operates and opens the holding path for the PH and P- relays. The T0 relay also locks until RA1 releases

at the start of the next digit. The PH relay in releasing releases AS and ASA, and opens the register relay operating grounds. The ASA relay in releasing transfers the counting relay output leads from the A digit register relays to the B digit register relays. The circuit now awaits the B digit.

Succeeding register and steering relays are operated as just described. When a marker start signal is received from the register, the AMRST waits for completion of steering and then causes the registration of a -7 only relay in the register position following the one in which the last digit had been registered. This permits matching the register which sends a -7 only relay to the marker as an end signal. The STS steering relay and the ST7 register relay permit registering a 7 beyond the last fully equipped digit.

P2-2 "TOUCH-TONE" RECEIVING (SFD-P207)

The following paragraphs describe how the AMRST registers and steers the TOUCH-TONE digits. TOUCH-TONE digits are received when monitoring originating registers that are handling calling subscribers with TOUCH-TONE sets.

When monitoring originating registers handling TOUCH-TONE calls, TOUCH-TONE frequencies generated by the calling subscriber are received simultaneously by the OR and AMRST. Once the OR is connected to the AMRST via the M relay, the ORM relay operates connecting the TOUCH-TONE receiver of the AMRST to the OR. The TOUCH-TONE frequencies generated by the calling subscriber are then registered and stored by both the OR and the AMRST (SFD-P207).

P2-2.1 "TOUCH-TONE" RECEIVER (SFD-P214)

If the monitored call is from a TOUCH-TONE set, the dial pulse amplifier is not used for receiving digits. Instead, a precise TOUCH-TONE receiver, connected to the tip and ring, is used.

For any valid signal, a combination of two audio frequencies is generated by the calling customers TOUCH-TONE set. Each valid combination of frequencies consists of one frequency from a "high" group of four frequencies, and another frequency from a "low" group of four frequencies. Ten of the sixteen combinations are used to represent the digits 0 to 9. The other six combinations are used for special signals. The output leads of the receiver are grounded to operate AMRST relays as indicated in the following table.

<u>Digit</u>	<u>Receiver Output Leads</u>	<u>Operated Translating Relays</u>	<u>Leads Grounded To 2/5 Register Relays</u>
0	HG2, LG4	Y9, Z2	4, 7
1	HG1, LG1	Y0, Z1	0, 1
2	HG2, LG1	Y0, Z2	0, 2
3	HG3, LG1	Y0, Z3	1, 2
4	HG1, LG2	Y3, Z1	0, 4
5	HG2, LG2	Y3, Z2	1, 4
6	HG3, LG2	Y3, Z3	2, 4
7	HG1, LG3	Y6, Z1	0, 7
8	HG2, LG3	Y6, Z2	1, 7
9	HG3, LG3	Y6, Z3	2, 7
10	HG4, LG1	Y0, Z4	0, 10
11	HG4, LG2	Y3, Z4	1, 10
12	HG4, LG3	Y6, Z4	2, 10
13	HG4, LG4	Y9, Z4	7, 10
14	HG1, LG4	Y9, Z1	4, 10
15	HG3, LG4	Y9, Z3	0, 15

The frequencies associated with each output lead are indicated in the following table:

<u>Lead</u>	<u>Frequency</u>
HG1	1209
HG2	1336
HG3	1447
HG4	1633
LG1	697
LG2	770
LG3	852
LG4	941

When a digit is keyed, one HG- lead and one LG- lead is grounded to the AMRST for a specified interval of time. In addition, lead STR is grounded as long as a valid input combination appears at the receiver input. Digit registration and control of steering is described in the next paragraph.

P2-2.2 "TOUCH-TONE" DIGIT REGISTRATION AND STEERING (SFD-P215-P216)

TOUCH-TONE digits are registered in and steered by the same relays that are used for dial pulse digits. However, the operation of these relays is slightly different with TOUCH-TONE.

When the first digit is keyed, one of the HG- leads, one of the LG- leads, and the STR lead are grounded. The STRG relay operates, operating STRA. The STRA relay operates TTK indicating a TOUCH-TONE call (SFD-P215). The TTK relay opens the operate path of AS and ASA to allow steering to advance (SFD-P211). Assuming the first digit is other than a 0, 1, 8, or 9, STRA closes ground through contacts of the A digit register to operate BS and BSA and advance the steering (SFD-P210). When the key is released, STRG releases, dropping AS and ASA. Subsequent digits are registered in a comparable manner except that no check is made that the digit is other than a 0, 1, 8, or 9.

P2-3 MULTIFREQUENCY PULSES RECEIVED BY AMRST (SFD-P208)

The following paragraphs describe how the AMRST steers, receives, registers and repeats the multifrequency digits. Multifrequency digits can be received when monitoring outgoing senders and incoming registers.

When monitoring multifrequency outgoing senders, multifrequency signals generated by the OS are received by the distant office and AMRST simultaneously. Once the OS is connected to the AMRST via the sender M relay, the MFS relay operates connecting the multifrequency amplifier and repeater and the MF receiver of the AMRST to the OS. The MF signals generated by the OS are then received and stored by both the distant office and the AMRST (SFD-P208).

When monitoring multifrequency incoming registers, multifrequency signals generated by the distant office are received simultaneously by the IR and the AMRST. Once the IR is connected to the AMRST via the incoming register M relay, the MFT relay operates connecting the multifrequency amplifier and repeater and MF receiver of the AMRST to the IR. The MF signals generated by the distant office are then received and stored by both the IR and the AMRST (SFD-P208).

P2-3.1 MULTIFREQUENCY PULSE REPEATING CIRCUIT (SFD-P208)

This circuit is arranged for completing a transmission circuit for the MF pulses from either an OS or an IR to the receiver used with the AMRST. The circuit is adjusted to provide the same signal level at the input to the receiver as that obtained at the output of the OS or input of the IR.

P2-3.1.1 Monitoring Multifrequency Outgoing Senders (SFD-P208)

The MFS relay (SFD-P108) is operated from the AMRST control circuit when the pulse repeating circuit is to be connected to an OS. The MFS operated connects the T and R leads from the OS to the MF2 repeating coil. It also connects the output of the MF1 transformer after attenuation by the MF pad to the MF receiver of the AMRST. The output of the MF2 repeating coil is connected through the MF3 capacitor to the grids of the MF electron tube. The combination of the MF3 capacitor and MF4A grid resistor correct for a slight change in transmission loss in other parts of the circuit over the 700- to 1700-cycle frequency band. Current flowing from the plus 130 volt office battery through the primary windings of the MF1 transformer, the plate to cathode circuit of the vacuum tube to ground through the MF1A resistor produces a voltage drop across the MF1A resistor. This voltage drop is impressed across the grid-cathode circuit and serves to automatically adjust the plate current. The value that will be reached is dependent upon the characteristics of the tube used. The MF1 capacitor is shunted across the MF1A resistor in order to maintain the grid bias at a constant average value when a modulating ac voltage is impressed on the grid during pulsing. A fraction of the ac voltage at the plates of the MF tube is fed back to the grid through the voltage divider circuit which consists of the MF2 capacitor and MF2A and MF3A resistors. Feeding back a portion of the ac voltage from the plates to the grids effectively reduces the change in voltage that an ac input signal will produce at the grids. This reduces the effective gain of the tube. The output of the MF1 transformer is reduced by the MF pad to approximately the same level that the MF receiver will receive when monitoring on an MF incoming register.

P2-3.1.2 Monitoring Multifrequency Incoming Registers (SFD-P208)

The MFR relay (SFD-P108) is operated from the AMRST control circuit when the pulse repeating circuit is to be connected to an IR. The MFR relay operated connects the T and R leads from the IR to the MF2 repeating coil. It also connects the output of the MF1 transformer to the MF receiver of the AMRST.

A circuit is provided through break contacts on the MFR and MFS relays for short circuiting the input to the MF2 coil. This provides a circuit for discharging the MF4 capacitor between operations.

P2-3.2 RECEIPT OF MULTIFREQUENCY PULSES BY INCOMING REGISTER

The frequencies comprising a digit pass through the MF amplifier into the receiving circuit. The MFR relay, when operated from MIR, operates MFN (SFD-P108). The MFN relay connects off-normal batteries to the multifrequency receiving circuit to the IR. The MFN relay connects ground and battery to the primary winding of PTO (SFD-P210) in a direction to operate this relay. However, a ground on the M lead from the multifrequency receiver is connected to the secondary winding of PTO in the nonoperate direction. Since the secondary winding is the more powerful, PTO is held on its break contact. The operation of the multifrequency amplifier is covered in Multifrequency Pulse Repeating Circuit.

Each signal sent consists of 2-out-of-5 audio frequencies designated 0, 1, 2, 4, and 7. In addition, a "key pulse" signal is sent first as a "gate opener", and a "start" signal consisting of frequencies 7 and 10 is sent after the last digit. The entire code used is as follows (note that the two numerical frequencies may be added to obtain the corresponding digit for digits 1 through 9):

<u>Digit</u>	<u>Frequencies</u>
0	4, 7
1	0, 1
2	0, 2
3	1, 2
4	0, 4
5	1, 4
6	2, 4
7	0, 7
8	1, 7
9	2, 7
KP	2, 10
ST	7, 10

Actual frequencies are as follows:

<u>Designation</u>	<u>Cycles per Seconds</u>
0	700
1	900
2	1100
4	1300
7	1500
10	1700

The KP signal is received entirely by the receiver without any effect on the register. As each subsequent digit is received, the receiver grounds two leads to the register circuit as indicated in the foregoing table and also synchronizes registration and steering on the H, J, and L leads.

P2-3.3 MULTIFREQUENCY DIGIT REGISTRATION AND STEERING (SFD-P210-P216)

For calls from dial pulse incoming registers, the steering and registration is as described in P2-1.3. For calls from multifrequency incoming registers, the steering is controlled from the multifrequency receiving circuits as described in the following paragraph.

When a signal is received, the receiver grounds the J lead to the AMRST. This is returned through break contacts of the T0 relay to the L lead where it operates the LK relay. The LK relay closes the operating circuit for the receiver channel relays 0, 1, 2, 4, and 7. With the AS and ASA relays operated, grounds from the operated channel relays will operate the corresponding A(0,1,2,4,7) relays. At this same time, the receiver grounds the H lead which operates the BS and BSA relays. A break contact of BS opens the locking path of AS and connects it in series with the T0 resistor to the H lead to the receiver. At the time the H lead is grounded, the receiver removes ground from the M lead permitting the PTL capacitor to start charging in series with the secondary winding of PTO. The PTO relay holds operated until the charging current and the secondary ampere turns are reduced to the point where the primary winding can operate the relay. When PTO operates, it connects to T0 relay in multiple with the T0 resistor and operates the T0 relay. The timed delay provided by PTO and its associated capacitor insures that the register relays operate before T0 operates to start release of the channel relays. The T0 opens the L lead to the receiver and locks to the J lead. The channel relays of the receiver release causing ground to be removed from the H and J leads and connected to the M lead from the receiver. The AS, ASA, and T0 relays release, PTO operates and the circuit is ready for the next digit.

If a start signal is received, the receiver will ground the 7 and 10 leads. The 10 relay and a -7 register relay will operate. The 10 relay locks and connects a ground to the J lead to hold T0 operated at the end of registering the 7. This prevents any further operation of the channel relays. Some incoming registers are arranged so that, if a full complement of digits is received, a CM is selected without waiting for a start signal since it may not be sent. Under this condition the final -7 is registered as previously described for the OR. This path is opened at the 10 relay to prevent registration of a second -7 if a start signal is received.

If the incoming registers are equipped to register one-one prefix codes, the TDM relay is provided. With this relay operated, a one-one prefix will be registered as for originating registers. The number checking and trouble indicating paths are so arranged that a single one will be accepted as a one-one. This follows the practice followed in the incoming registers.

Under certain conditions where the AMRST is equipped for more digits than the MF incoming register, a mismatch may result if the attendant inadvertently keys an extra digit or if the pulse for the last equipped register digit is of long duration and is split sufficiently by the surge produced under adverse conditions when the MF register opens the dc supervisory circuit for the AMRST MF receiver to recycle.

SECTION P, PART 3

PULSE CHECKING AND RELEASE

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P3 PULSE CHECKING AND RELEASE

(a) Originating Register Monitoring

After all the digits have been received by the OR and AMRST, the OR seizes a CM through the ORMC. The CM realizing it is handling a Monitored (MON) call seizes the MTFC which connects to the AMRST. The digits stored in the OR, along with other information, is passed through the ORMC, CM, and MTFC to the AMRST where they are compared against the digits pulsed into the AMRST. If the digits match, the AMRST restores to normal and is ready to accept the next call. If they do not match a trouble record is taken and then the AMRST is ready to accept the next call.

(b) Outgoing Sender Monitoring

After the OS completes outpulsing, the digits outpulsed by the sender into the AMRST are compared against the digits received from the CM via the MTFC. If the digits match, the AMRST restores to normal and is ready to accept the next call. If they do not match a trouble record is taken and then the AMRST is ready to accept the next call.

(c) Incoming Register Monitoring

After all the digits have been received by the IR and AMRST, the IR seizes a CM through the IRMC. The CM realizing it is handling a MON call seizes the MTFC which connects to the AMRST. The digits stored in the IR, along with other information, are passed through the IRMC, CM, and MTFC to the AMRST where they are compared against the digits pulsed into the AMRST. If the digits match, the AMRST restores to normal and is ready to accept the next call. If they do not match a trouble record is taken and the AMRST is ready to accept the next call.

P3-1 ORIGINATING REGISTER MONITORING

The following paragraphs describe how the digits simultaneously received by the OR and the AMRST are compared with each other. After the calling subscriber has completed dialing, the OR seizes a CM. The CM realizing it is handling a MON call, seizes the MTFC and passes the digits received from the OR to the AMRST where they are compared with the digits received by the AMRST. If the digits match, the AMRST releases and is ready to accept another call. If the digits do not match, the AMRST takes a trouble record.

P3-1.1 PULSE END AND CONNECTION TO CM (SFD-P212)

When the OR recognizes that pulsing is completed, it connects to a CM through the ORMC. At the same time, the AMRST connects to the CM through the MTFC to obtain the information transmitted from OR to CM.

When the OR starts to select a CM, ground is removed from the MST lead causing RPE1 to operate (SFD-P108). The RPE1 relay opens the L relay path (SFD-P213) to prevent the AMRST from registering any further pulses. In some cases, the OR returns a coin or makes 2-party or coin test before seizing a CM and opening the MST lead. To prevent the AMRST from receiving a false pulse during these operations, ground is received on the MST1 lead (SFD-P212) at the start of any of these operations. This ground operates EMP which opens the L relay path. The RPE1 relay operates relay PEA. The PEA relay opens the MST lead which recycles and changes the timing interval of the AMRST timer (SFD-P115). Ground from PEA is closed through break contacts of PH to operate PE. The PE relay operated closes ground through break contacts of the AS relay, break contacts of relay 10 and make contacts of an operated steering relay to operate the -7 register relay of the digit beyond the last pulsed digit (SFD-P213). The lead is wired through break contacts of AS to prevent operating the A7 relay on a permanent signal call. On such a call, a register does not operate its A7 relay. The PE relay is made slow operate and its operating circuit is wired through break contacts of PH to insure that the monitor steering circuit advances to the next position before a -7 relay is operated.

When the ORMC connects the OR to a CM, a circuit is established through the MM relay of the AMRST over the MON lead to the OR to operate the MON relay in the CM to prepare it for a MON call (SFD-P212). The MM relay operates in series with the MON relay of the CM. The MON relay locks to MM on the direct MONL lead from CM to AMRST. The MM relay completes the circuit from resistance battery to the TRST lead to operate the monitor preference relay MPR-, in the MTFC (SFD-P306). The MM relay also connects ground to the NRR lead to operate the NRR relay if the MTFC is busy (SFD-P317).

When the MTFC is busy, it operates the TRB relay (SFD-P317) of the AMRST which opens the TRST lead (SFD-P306) to prevent seizure of the MTFC until it is fully released. If TRB is operated when MM operates, a circuit is closed to operate NRR (SFD-P317). The NRR relay locks and opens the TRST lead to prevent any further attempt to seize the MTFC. The AMRST does not attempt to check the number under this condition but releases as on an abandoned call after the OR and CM release. This practice is followed to prevent the AMRST from being connected to the CM at so late a time that satisfactory monitoring of the call would be impossible.

Assuming that the MTFC is not busy, battery from RPE1 on the TRST lead operates the AMRST preference relay in the MTFC (SFD-P306) which operates the CI relay (SFD-P307). The CI relay opens the operating path of TRB (SFD-P317) and closes ground to the ON lead to operate off-normal relays in the MTFC (SFD-P307). The CI relay operates CII which operates the MCA, MCB, and MCD multicontact relays which connect groups of leads from the AMRST to the MTFC. The MTR1 relay operates through CI to open the TRB lead. The CI relay also connects ground to the MKB lead to the marker (SFD-P306). This lead is multiplied to all markers but is effective only in the marker with an operated MON relay where it is extended to operate the multicontact relays in the MTFC which connect that CM to the MTFC for monitoring operation. The AMRST is now connected to the CM through the MTFC and registers information necessary for monitoring purposes.

P3-1.2 Registration of Information From CM (SFD-P308,P312)

The physical location of the calling line is recorded through the MCA relay. This information is stored for use if a trouble record is made. The vertical group location of the calling line is recorded on the VG(0,1,2,4,7,10) relays on a 2-out-of-6 basis. The vertical file location of the calling line is recorded on the VF(0-4) relays on a 1-out-of-5 basis. The horizontal group location of the calling line is recorded on the HG(0,1,2,4,7) relays on a 2-out-of-5 basis. The units of the number of the line link frame on which the calling line is located is recorded on the FU(0,1,2,4,7) relays on a 2-out-of-5 basis. The tens digit of the number of the LL frame on which the calling line is located is recorded on the FT(0-3) relays on a 1-out-of-4 or 2-out-of-4 basis.

The number of the marker handling the call is recorded through the MCA relay. One of the relays M(0-9) operates for the units number and, if there are more than 10 markers, one of the relays MKT(0-1) operates for the tens number.

The called number information passed from OR to CM is closed through the MCB relay (SFD-P312). Five leads for each of 11-digits are provided and an M7 lead to register a 7 beyond the last digit. The K- relays operate in each digit position to correspond to the information passed from OR to CM. The operated relays lock and control the number checking path in combination with the register relays previously operated by the AMRST.

P3-1.3 RELEASE OF MASTER TEST FRAME CONNECTOR (SFD-P306,307)

When the CM has reached the point of operating the channel hold magnets, it grounds the HMS1 lead to the AMRST to operate the RTC1 relay. The RTC1 relay locks, opens the TRST lead to release the MTFC, opens the

MON1 lead to the CM and operates RTC2. The MON1 relay was operated from a ground on the MON1 lead from the CM. The MON1 relay provides a signal from CM to AMRST before normal release of the marker takes place.

When the monitor preference relay in the MTFC releases, CI releases to remove ground from the ON lead to the MTFC to complete its release. The CI relay removes ground from the MKB lead to the CM to release the cut-in relays at the marker end of the MTFC. The CI relay also releases CII which releases MCA, MCB, and MCD relays at the AMRST end of the connection to the CM. When the MTFC completes its release, MTR1 is released and closes the TRB lead. This control of the TRB lead prevents operation of TRB during release of the MTFC.

The RTC2 relay operating prevents the AMRST from interpreting normal release of the OR as an abandoned call. The RCT2 relay also opens the operate path of NRR from relay MM if TRB is operated. This path is opened since TRB may operate if the MTFC is seized after its release by the AMRST. The RTC2 relay also closes a path to operate CKS (SFD-P316) to start checking the number.

P3-1.4 NUMBER CHECKING (SFD-P314)

The CKS relay locks and connects resistance battery to the check path. If the numbers registered in that figure check, this battery is returned to operate CKN. Each relay used in registering the pulsed number as received by the AMRST is paired with a corresponding relay which records the number passed from OR to CM. For instance A0, A1, A2, A4, and A7 are paired, respectively, with KA0, KA1, KA2, KA4, and KA7. The check path is wired through the break contacts of a relay pair in series, a paralleling path being wired through the make contacts of the pair in series. Hence, completion of the check path requires that the two numbers be exactly the same. At the time CKS closed battery to the check path, it also closed the operating path for CKE (SFD-P316). The CKE relay is slow-operate to permit the CKN to operate if the check path is complete.

When CKE operates, ground is connected through break contacts of CKN to operate TRR1 and cause a trouble record to be made, or through make contacts of CKN to release the AMRST and OR.

P3-1.5 TROUBLE RECORD (SFD-P316)

If TRR1 operates, it locks and operates TRR2. The TRR1 relay closes ground to the MN lead to the master test frame jack, lamp, and key circuit to indicate with an audible alarm that a trouble record is being made. The TRR2 relay opens the OK release lead to prevent a late number

check from releasing the AMRST. The TRR2 relay also closes a ground through ORN to operate a plant register which indicates the number of OR troubles encountered. The MKB lead is opened by TRR1 to prevent operating marker cut-in relays.

The TRR1 relay closes battery to the TRST lead to operate the AMRST preference relay in the MTFC (SFD-P306). If the MTFC is busy, the AMRST waits a timed interval and then operates the DL relay and releases as described in Timing During Monitored Calls (Par. P1-5). If it is idle or becomes idle during the timed interval, the AMRST gains access and CI operates. The CI relay closes a ground to the ON lead to operate off-normal relays in the MTFC and operates CII. The CII relay closes ground from break contacts of TRR1 to the STR lead. The latter ground is extended through the MTFC to the trouble recorder control circuit which prepares the trouble recorder and MTFC to receive a trouble record. The CII relay operates the MCA, MCB, and MCE relays.

The relays previously operated to record the calling line location, marker number, and the called number passed from OR to CM extend their locking grounds into the MTFC through the MCA and MCB relays. Similarly, the called number registered directly by the AMRST is extended through the MCE relay to the MTFC (SFD-L114). The MOR lead to the MTFC is grounded through ORN and MCA to indicate that the trouble record is being made on a monitored OR call (SFD-P307).

The OR may release during the trouble record but its M and MB relays will be held operated from the AMRST. The M relay is held to permit the OR identification to be included in the trouble record. The MB is held to prevent reseizure of the OR while the M relay is operated. The MCA relay connects ground to the RG, CN, and FR leads to the OR where they are extended through the M relay to leads to the MTFC which identify the OR. The RG, FR, and CN leads are used respectively to indicate the position of the OR in its marker connector, the frame on which the marker connector is located, and the position of the marker connector on that frame.

After a trouble record card has been perforated in accordance with information conveyed by grounded leads extending from the AMRST to the trouble recorder through the monitor to the trouble recorder through the MTFC, ground is connected to the TRC lead to operate the TRC relay. The TRC relay locks and opens the TRST lead to release the MTFC trouble recorder, and the CI, CII, MCA, MCB, MCE, and MTR1 relays of the AMRST.

The TRC relay also closes a ground to operate the RN relay if the HLD key is normal. The HLD key is provided to permit holding the OR for trouble tracing in the event the trouble recorder is out of service. This key should not be operated when the trouble recorder is available.

If no trouble is found, the RN relay operates and opens the OR holding ground and both AMRST and OR release. If a trouble is found, a trouble record is made and the operation proceeds to the point of operating the RN relay. The operating circuit of RN is open with the HLD key operated and the AMRST and OR remain locked off-normal.

P3-1.6 AMRST RELEASE (SFD-P316)

In restoring the AMRST to normal, the RN relay is operated either from TRC if a trouble record has been made, or OK if the number check was satisfactory. An OK release signal is also received if a call is abandoned or if a trouble release is received from the CM. The operating circuit for RN is through break contacts of MM to insure that the CM involved in the call releases before the AMRST. The MON relay of the CM locks in series with the MM relay until the CM restores to normal so that, if the CM encounters trouble, it can indicate on the trouble card that the call was monitored. With the MON relay of one marker operated, the AMRST is prevented from restoring to normal and then operating the MON of a second marker.

The RN relay opens the locking path of the DOR relay (SFD-P112) and the holding circuits of the M and MB relays of the OR. The MB relay is released by RN (SFD-P114). The M relay is released from RN so that the AMRST can free itself from a register while it is stuck and holding ground on the ON lead. Relays DOR, ORN, ONM1, and ONM2 release in turn. Each of these relays control relays in the AMRST which release. The ONM1 relay releases MSR which is slow-release to permit all relays of the AMRST to release before MSR1 which functions to permit the AMRST to receive another call.

During the period of monitoring on a particular OR, the M relay of the OR will be locked to the MPOR key (see P1-4.1). A ground through make contacts of the MSR1 relay and the MPOR key is connected directly to the MB lead to the OR. This holds the register busy until the AMRST is fully restored to normal.

P3-1.7 ABANDONED CALLS (SFD-P316)

If a call is abandoned, the OR removes ground from the H lead releasing MAC1 which connects ground from MAC2 through to operate RN and restore the AMRST to normal. The RTC2 relay control of this circuit is provided to prevent the normal release of the OR from releasing the AMRST. The TRR2 control prevents an abandoned call from releasing the AMRST while the AMRST is making a trouble record as the result of a time out prior to operation of RTC2.

P3-1.8 TRAFFIC REGISTRATION (SFD-P317)

A count is kept of the number of OR calls which are monitored. The MPC1 and MPC2 relays control this registration. When ONM1 operates at the start of a call, the MPC2 operates when the RTC2 relay operates at the end of dialing. The MPC2 relay closes ground through the ORN relay to the OR lead to the plant register circuit where it operates the register which counts OR calls. The MPC2 relay also operates MPC1 which releases MPC2. The MPC2 relay is slow-release to provide time for the register to operate. Relay MPC1 is slow-operate to provide soak time for MPC2 relay. The registers are operated on a pulse because their high current drain makes it inadvisable to hold them operated for extended periods. Other contacts on MPC2 control registration of outgoing sender and incoming register calls.

When troubles are encountered, registration is made on the ORF, IRF, or OSF lead through the TRR2 relay operated and the ORN relay for originating registers, the IRN relay for incoming registers, and the SON relay for outgoing senders.

P3-2 OUTGOING SENDER MONITORING

The following paragraphs describe how the AMRST compares the digits simultaneously passed to the OS and the AMRST with the digits outputted by the OS and received by the AMRST. When the CM passes the digits to the OS it also passes these same digits to the AMRST via the MIFC. When the digits are outputted by the OS to the distant office, they are also registered in the AMRST where they are compared with the digits previously received from the CM. If the digits match, the AMRST releases and is ready to accept another call. If the digits do not match, the AMRST takes a trouble record.

P3-2.1 PULSE END AND NUMBER CHECKING (SFD-P314)

When a dial or MF outgoing sender has completed outputting, it will ground the SPE lead to the AMRST (SFD-P212) which operates the SPE1 relay. The SPE1 relay locks and opens the OS abandoned call release path to prevent any further recognition of abandoned calls. When PH releases, ground is returned by SPE1 to operate PE. The PE relay connects ground through break contacts of the AS relay (SFD-P213) and make contacts of an operated steering relay to operate the -7 register relay of the digit beyond the last pulsed digit (SFD-P216,P217). The PE relay is made slow-operate and its operating circuit wired through break contacts of PH to insure that the AMRST steering circuit advances to the next position before a -7 relay is operated. The PE relay also operates CKS (SFD-P316), which is slow-operate to permit the -7 relay to operate before the check is started.

The CKS relay closes resistance battery through the number check path (SFD-P314). The following description covers the check path for dial and multifrequency outgoing senders. Each relay used in registering the pulsed number as received by the AMRST is paired with a corresponding relay which records the number passed from OR to CM. For instance A0, A1, A2, A4, and A7 are paired, respectively, with KA0, KA1, KA2, KA4, and KA7. In the case of a preliminary one-one, TD1 is operated from the marker and matched with S11, S01, S12, and S02. The check path is wired through the break contacts of a relay pair in series, a paralleling path being wired through the make contacts of the pair in series. Hence, completion of the check path requires that the two numbers be exactly the same. If a DL- relay is operated, it bypasses the check path around the OR relays of digits which are not outputted.

If the two called numbers match, CKN will operate and lock. The CKS relay also operates CKE which is slow-operate to permit CKN to operate. The CKE relay closes ground to the armature of a transfer of CKN. If CKN is operated, this ground releases the AMRST and OS. If CKS is not operated, ground from CKE operates TRR1 to start a trouble record.

P3-2.2 TROUBLE RECORD (SFD-P316)

This operation is the same as described for an OR (see P3-5.1) with exceptions as follows:

A plant register indicating OS troubles recorded is operated through SON. The MOS lead to the MTFC is grounded through M01 to indicate that the trouble is on a monitored OS call. The OS is held busy by its SB relay. The hold feature is not operative for outgoing senders since the trouble release path is closed at SON if the HLD key is operated.

The information furnished for the trouble record is: CM number, OS location, outgoing trunk location, calling line location, called number recorded directly by the AMRST, and the called number passed from OR to CM. The S, FR, and CN leads from MCA are used respectively to indicate (through the M relay of the sender) the position of the OS in its Outgoing Sender Connector (OSC), the frame on which the connector is located, and the position of the OSC on the frame (SFD-L326). In addition, TR and TR2 operate when a trouble record is made and furnish ground for indicating the information relative to the outputted number passed from CM to OS and recorded in the AMRST through the MCI, MCJ, MCK, and MCL relays. Individual grounds are provided from TR and TR2 for this trouble indicating to prevent backup which might occur during marker operation if a common locking lead were provided for the DL- and CL- and KR- relays. The MCA, MCB, MCC, MCE, MCI, and MCJ relays connect this trouble record information to the MTFC.

In case an outgoing dial pulse or multifrequency sender is being monitored and some trouble condition prevents advance of the sender steering circuit (SFD-P108), the same digit will be outputted repeatedly and this will cause the steering circuit to be counted down, finally causing the operation of the trouble steering relay TRS. The TRS relay causes operation of TRR1 to cause a trouble record to be made.

P3-2.3 AMRST RELEASE (SFD-P316) .

In restoring the AMRST to normal, the RN relay is operated either from TRC if a trouble record has been completed or from OK if the number check was satisfactory. An OK release signal is also received if a call is abandoned or if a trouble release is received from the CM. Operation of RN is delayed until the CM releases.

The RN relay locks to ONM1 and opens the locking circuit of SON which releases. The RN relay removes ground from the LK lead to the OS to release the M relay (SFD-P114) and ground from the SG lead to release DOS, ROS, COS, or MOS (SFD-P112). The SON relay releases ONM1 and ONM2 (SFD-P108). Each of these relays controls relays in the AMRST which release. The ONM1 relay releases MSR which is slow-release to permit all relays of the AMRST to release before MSR1 releases to permit the AMRST to receive another call (SFD-P108).

During the period of monitoring on a particular OS, the M relay of the OS will be locked to the MPOS key. A ground through make contacts of the MSR1 relay and the MPOS key is connected directly to the SB lead to the sender. This holds the sender busy until the AMRST is fully restored to normal.

P3-2.4 ABANDONED CALLS (SFD-P316)

If a call is abandoned, the OS removes ground from the H lead releasing MAC1 (SFD-P108) which connects ground from MAC2 through SON through break contacts of SPE1 and TRR2 to operate RN and restore the AMRST to normal. The control of this circuit by the SPE1 relay prevents the normal release of the OS from releasing the AMRST. The TRR2 control prevents an abandoned call from releasing the AMRST while the AMRST is making a trouble record as the result of a time out prior to operation of SPE1. The break contact of SPE1 controlling this path is shunted by a make contact of NRR since it is necessary to use the abandoned call release path when NRR operates following SPE1.

P3-2.5 TRAFFIC REGISTRATION (SFD-P317)

A count is kept of the number of OS calls which are monitored. The MPC1 and MPC2 relays control this registration. When ONM1 operates at the start of a call, the MPC2 operates when the RTC2 relay operates at the end of dialing. The MPC2 relay closes ground through the SON relay to the OS lead to the plant register circuit where it operates the register which counts OS calls. The MPC2 relay also operates MPC1 which releases MPC2. The MPC2 relay is slow-release to provide time for the OS to operate. Relay MPC1 is slow-operate to provide soak time for MPC2 relay.

When troubles are encountered, registration is made on the ORF, IRF, or OSF lead through the TRR2 relay operated and the ORN relay for OR, the IRN relay for IR, and the SON relay for OS.

P3-3 INCOMING REGISTER MONITORING

The following paragraphs describe how the digits simultaneously received by the IR and the AMRST are compared with each other. After the distant office has completed pulsing, the IR seizes a CM. The CM realizing it is handling a monitored call, seizes the MTFC and passes the digits received from the IR to the AMRST where they are compared with the digits received by the AMRST. If the digits match, the AMRST releases and is ready to accept another call. If the digits do not match the AMRST takes a trouble record.

P3-3.1 PULSE END AND CONNECTION TO CM (SFD-P212)

When the incoming register recognizes that pulsing is completed, it connects to a CM through the IRMC. At the same time, the AMRST connects to the CM through the MTFC to obtain the information transmitted from IR to CM.

When the IR starts to select a CM, ground is removed from the MST lead causing RPE1 to operate in series with RPS1 (SFD-P108) and operate an auxiliary PEA relay (SFD-P212). For direct pulsing calls to a dial incoming register, RPS1 is paralleled by the operated DP relay of the IR. To prevent DP from releasing and causing a false pulse to the AMRST by opening the loop to the IR, DP is held in series with RPE1 until PEA operates. Thus, RPE1 operates and breaks the pulsing path in the AMRST before PEA operates to release DP in the IR by opening the MST lead to the IR.

Ground from RPE1 is closed through break contacts of PH to operate PE. For dial and multifrequency registers, PE closes ground through break contacts of the AS relay (SFD-P213), break contacts of the 10 relay, and make contacts of an operated steering relay to operate the -7 register relay of the digit beyond the last registered digit (SFD-P216,P217). When a start signal is received, this path is opened by the 10 relay since the -7 register relay will be operated from the multifrequency receiver (SFD-P213). The PE relay is made slow-operate and its operating circuit wired through the break contacts of PH to insure that the AMRST steering circuit advances to the next position before a -7 relay is operated.

The RPE1 relay also connects resistance battery to the TRST lead to operate the AMRST preference relay in the MTFC. When the IRMC connects the IR to a CM, a circuit is established through the MM relay over the MON lead to the IR to operate the MON relay in the CM to prepare it for a monitored call (SFD-P212). The MM relay operates in series with the MON relay of the CM. The MON relay locks to MM on the direct MONL lead from CM to AMRST. The MM relay prepares a path for operating NRR. When MON operates, ground from RPS1 on the SCT lead to the CM operates a relay to bypass a delay circuit which is inserted in the OS operation of the CM (SFD-P306). This delay is not necessary during IR.

When the MTFC is busy, it operates the TRB relay (SFD-P317) of the AMRST which opens the TRST lead (SFD-P306) to prevent seizure of the MTFC until it is fully released (SFD-P317). If TRB is operated when MM operates, a circuit is closed to operate NRR. The NRR relay locks and opens the TRST lead to prevent any further attempt to seize the MTFC. The AMRST does not attempt to check the number under this condition but releases as on an abandoned call after the IR and CM release. This practice is followed to prevent the AMRST from being connected to the CM at so late a time that satisfactory monitoring of the call would be impossible.

Assuming that the MTFC is not busy, battery from RPE1 on the TRST lead operates the AMRST preference relay in the MTFC (SFD-P306) which operates the CI relay (SFD-P307). The CI relay opens the operating path of TRB (SFD-P317) and closes ground to the ON lead to operate off-normal relays in the MTFC (SFD-P307). The CI relay operates CI1 which operates the MCA, MCB, and MCD multicontact relays which connect groups of leads from the AMRST to the MTFC. The MTR1 relay operates through CI to open the TRB lead. The CI relay also connects ground to the MKB lead to the marker (SFD-P306). This lead is multiplied to all markers but is effective only in the marker with an operated MON relay where it is extended to operate the multicontact relays in the MTFC which connect that CM to the MTFC for monitoring operation. The AMRST is now connected to the CM through the MTFC and registers information necessary for monitoring purposes.

P3-3.2 REGISTRATION OF INFORMATION FROM CM (SFD-P309,P310,P312)

The information registered in the AMRST differs somewhat from that obtained during OR monitoring. Additional information is obtained through the MCC relay which is operated in addition to the MCA and MCB relays. The called number passed from IR to CM is registered through the MCB relay. The marker number is registered through the MCA. There is no calling line information. The number of the trunk link frame on which the trunk appears is carried through the MCA relay. The units of this number are registered by the TF(0,1,2,4,7) relays on a 2-out-of-5 basis and the tens digit on the FG(0-2) relays on a 1-out-of-3 basis. A number indicating the line link appearance of a tandem trunk is carried through the MCC relay and registered on a 2-out-of-5 basis on the HT(0,1,2,4,7) for the hundreds digit, the TT(0,1,2,4,7) for the tens digit and the UT(0,1,2,4,7) for the units digit. Where up to 2000 trunks may be furnished the thousands digit is registered on the THT (0-1) relays on a 1-out-of-2 basis.

The location of the incoming trunk on the TL frame is carried through the MCC relay. A 226-ohm battery connected through the MCC relay to the TRA lead to the MTFC and then to the trunk link frame through the marker cut-in relays causes operation of relays which furnish trunk location information to the AMRST (shown on SFD-K217). The switch on which the trunk appears is registered on the LC(0-9) relays on a 1-out-of-10 basis. The level on the switch is registered on the LV(2-9) relays on a 1-out-of-8 basis. The FAK and FBK relays register whether the trunk is an A or B appearance on the switch level. The FS(0-19) relays operate directly from the CM and indicate the trunk link frame number on which an out trunk appears on a 1-out-of-20 basis. On local incoming calls the FS(0-19) relays will not operate (SFD-P309). On tandem calls the information given by the FS-, LC-, LV-, and FA- relays would locate the outgoing trunk used. The incoming trunk used would be obtained from the HT-, TT-, and UT relays which give the tandem trunk number.

The trunk location information relays of the AMRST are not locked up until the CM grounds the HMS1 lead to the AMRST. This indicates that the CM has reached the point of operating the channel hold magnets. This registration delay is not necessary for IR monitoring. On OS monitoring this delay is necessary because the CM may change trunks prior to grounding the HMS1 lead.

The HMS1 ground through MCA and IRN operates TLG (SFD-P307). The TLG relay locks and operates LVG, LCG, FSG1, and FSG2. These relays furnish locking grounds for the trunk location relays. When all the ground supply relays have operated, a ground is connected to operate RTC1 and start release of the MTFC.

P3-3.3 RELEASE OF MASTER TEST FRAME CONNECTOR (SFD-P306,307)

When the CM has reached the point of operating the channel hold magnets, it grounds the HMS1 lead to the AMRST to operate the RTC1 relay. The RTC1 relay locks, opens the TRST lead to release the MTFC, opens the MON1 lead to the CM and operates RTC2. The MON1 relay was operated from a ground on the MON1 lead from the CM. The MON1 relay provides a signal from CM to AMRST before normal release of the marker takes place.

When the monitor preference relay in the MTFC releases, CI releases to remove ground from the ON lead to the MTFC to complete its release. The CI relay removes ground from the MKB lead to the CM to release the cut-in relays at the marker end of the MTFC. The CI relay also releases C11 which releases MCA, MCB, and MCD relays at the AMRST end of the connection to the CM. When the MTFC completes its release, MTR1 is released and closes the TRB lead. This control of the TRB lead prevents operation of TRB during release of the MTFC.

The RTC2 relay operating prevents the AMRST from interpreting normal release of the OR as an abandoned call. The RCT2 relay also opens the operate path of NRR from relay MM if TRB is operated. This path is opened since TRB may operate if the MTFC is seized after its release by the AMRST. The RTC2 relay also closes a path to operate CKS (SFD-P316) to start checking the number.

P3-3.4 . NUMBER CHECKING (SFD-P314)

The CKS relay locks and connects resistance battery to the check path. If the numbers registered in that figure check, this battery is returned to operate CKN. Each relay used in registering the pulsed number as received by the AMRST is paired with a corresponding relay which records the number passed from OR to CM. For instance A0, A1, A2, A4, and A7 are paired, respectively, with KA0, KA1, KA2, KA4, and KA7. The check path is wired through the break contacts of a relay pair in series, a paralleling path being wired through the make contacts of the pair in series. Hence, completion of the check path requires that the two numbers be exactly the same. At the time CKS closed battery to the check path, it also closed the operating path for CKE (SFD-P316). The CKE relay is slow-operate to permit the CKN to operate if the check path is complete.

When CKE operates, ground is connected through break contacts of CKN to operate TRR1 and cause a trouble record to be made, or through make contacts of CKN to release the AMRST and OR.

P3-3.5 TROUBLE RECORD (SFD-P316)

If TRR1 operates, it locks and operates TRR2. The TRR1 relay closes ground to the MN lead to the master test frame jack, lamp, and key circuit to indicate with an audible alarm that a trouble record is being made. The TRR2 relay opens the OK release lead to prevent a late number

check from releasing the AMRST. The TRR2 relay also closes a ground through ORN to operate a plant register which indicates the number of OR troubles encountered. The MKB lead is opened by TRR1 to prevent operating marker cut-in relays.

The TRR1 relay closes battery to the TRST lead to operate the AMRST preference relay in the MTFC (SFD-P306). If the MTFC is busy, the AMRST waits a timed interval and then operates the DL relay and releases as described in Timing During Monitored Calls (Par. Pl-5). If it is idle or becomes idle during the timed interval, the AMRST gains access and CI operates. The CI relay closes a ground to the ON lead to operate off-normal relays in the MTFC and operates CII. The CII relay closes ground from break contacts of TRR1 to the STR lead. The latter ground is extended through the MTFC to the trouble recorder control circuit which prepares the trouble recorder and MTFC to receive a trouble record. The CII relay operates the MCA, MCB, and MCE relays.

The relays previously operated to record the calling line location, marker number, and the called number passed from OR to CM extend their locking grounds into the MTFC through the MCA and MCB relays. Similarly, the called number registered directly by the AMRST is extended through the MCE relay to the MTFC (SFD-L114). The MOR lead to the MTFC is grounded through ORN and MCA to indicate that the trouble record is being made on a monitored OR call (SFD-P307).

The OR may release during the trouble record but its M and MB relays will be held operated from the AMRST. The M relay is held to permit the OR identification to be included in the trouble record. The MB is held to prevent reseizure of the OR while the M relay is operated. The MCA relay connects ground to the RG, CN, and FR leads to the OR where they are extended through the M relay to leads to the MTFC which identify the OR. The RG, FR, and CN leads are used respectively to indicate the position of the OR in its marker connector, the frame on which the marker connector is located, and the position of the marker connector on that frame.

After a trouble record card has been perforated in accordance with information conveyed by grounded leads extending from the AMRST to the trouble recorder through the monitor to the trouble recorder through the MTFC, ground is connected to the TRC lead to operate the TRC relay. The TRC relay locks and opens the TRST lead to release the MTFC trouble recorder, and the CI, CII, MCA, MCB, MCE, and MTR1 relays of the AMRST.

The TRC relay also closes a ground to operate the RN relay if the HLD key is normal. The HLD key is provided to permit holding the OR for trouble tracing in the event the trouble recorder is out of service. This key should not be operated when the trouble recorder is available.

If no trouble is found, the RN relay operates and opens the OR holding ground and both AMRST and OR release. If a trouble is found, a trouble record is made and the operation proceeds to the point of operating the RN relay. The operating circuit of RN is open with the HLD key operated and the AMRST and OR remain locked off-normal.

A plant register indicating IR troubles recorded is operated through IRN (SFD-P317). The MIR lead to the MTFC is grounded through MCA and IRN to indicate that the trouble record is on a monitored IR call. The IR is held busy by its MB relay. The hold feature functions through the DIR or MIR to hold the ON relay of the IR. The information furnished for the trouble record is the CM number, the IR location, the trunk location, the tandem trunk number, the called number recorded directly by the AMRST, and the called number passed from the IR to CM. The MCA, MCB, MCC, and MCE relays (SFD-P307) connect this information to the MTFC.

P3-3.6 AMRST RELEASE (SFD-P316)

In restoring the AMRST to normal, the RN relay is operated either by TRC if a trouble has been recorded or by CKN if the number check was satisfactory. A release signal is also received if a call is abandoned or if a trouble release is received from the CM. Operation of RN is delayed until the CM releases.

The RN relay locks to ONM1 and releases IRP-. The IRP- relay releases M and MB of the IR and DIR or MIR of the AMRST (SFD-P110). The DIR, or MIR relay releases IRN which releases ONM1 and ONM2. Each of these relays controls relays in the AMRST which release. The ONM1 relay releases MSR which is slow-release to permit all relays of the AMRST to release before MSR1 which functions to permit the AMRST to receive another call (SFD-P108).

P3-3.7 ABANDONED CALLS (SFD-P316)

If a call is abandoned, the IR removes ground from the H lead releasing MAC1 which connects ground from MAC2 through to operate RN and restore the AMRST to normal. The RTC2 relay control of this circuit is provided to prevent the normal release of the IR from releasing the AMRST. The TRR2 control prevents an abandoned call from releasing the AMRST while the AMRST is making a trouble record as the result of a time out prior to operation of RTC2.

P3-3.8 TRAFFIC REGISTRATION (SFD-P317)

A count is kept of the number of IR calls which are monitored. The MPC1 and MPC2 relays control this registration. When ONM1 operates at the start of a call, the MPC2 operates when the RTC2 relay operates at the end of dialing. The MPC2 relay closes ground through the IRN relay to

the IR lead to the plant register circuit where it operates the register which counts IR calls. The MPC2 relay also operates MPC1 which releases MPC2. The MPC2 relay is slow-release to provide time for the register to operate. Relay MPC1 is slow-operate to provide soak time for MPC2 relay. The registers are operated on a pulse because their high current drain makes it inadvisable to hold them operated for extended periods.

When troubles are encountered, registration is made on the ORF, IRF, or OSF lead through the TRR2 relay operated and the ORN relay for OR, the IRN relay for IR, and the SON relay for OS.

